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Shipbuilding in Navy Yards

IN PASSING the naval bill, authorizing the construction of 15 cruisers and one aircraft carrier at an estimated cost of $274,000,000, the House of Representatives adopted an amendment providing that 8 of the 15 cruisers shall be built in Government navy yards. This amendment is not only wasteful but is wholly at variance with the fundamental principles of American government and should be striken from the bill before it becomes a law.

Naval vessels built in Government navy yards not only cost more than those built in private yards but every contract taken away from the private yards increases the cost of the work remaining in the private yards. Consequently, this amendment if it goes into effect means a sheer waste of millions of dollars of the taxpayers' money, which would be eliminated if all the work were carried out in private shipyards.

The private yards can build ships at minimum cost only when their plants are operating at normal capacity. When production falls off, unit costs increase, due to the heavy fixed overhead charges and the loss of efficiency in the operating forces. In the 3 large private shipyards in this country that are experienced in naval construction, production, due to the lack of both naval and merchant work, is at the lowest point in the history of the shipbuilding industry. If half of the ships in the proposed naval construction program are built in navy yards the private yards will not have sufficient work for operation at maximum efficiency nor can the ships be built at minimum cost. With the costs in the private yards relatively high and the costs in the navy yards higher still, the taxpayers will be forced to pay an exorbitant price for the new ships.

The building of ships by the Government in competition with its citizens has never been justified except in war times. It has always been a costly procedure and it has imposed an unjust handicap upon the shipbuilding industry. It is useful only to politicians as a means of securing political support in return for the local patronage that follows in its wake. As a pork barrel measure, if for no other reason, the provision for Government shipbuilding should be killed.

A New Shipping Bill

AS A RESULT of the extensive hearings held before the House committee on merchant marine and fisheries last month a new shipping bill is being drafted by a special sub-committee which it is expected will be reported out to the House at an early date. As many members of the House committee are extremely anxious to enact constructive legislation for the development of the merchant marine, every effort is being made to frame a practical bill that will be acceptable to a majority of both the Senate and the House. It is understood that the bill, to be known as the Jones-White Bill, will provide liberal terms for loans from the Shipping Board for the construction of new vessels, higher rates for carrying mails on long term contracts and payments for the services of officers and men enrolled in the naval reserve. It is to be hoped however that the bill will contain further provisions for financial aid for both the construction and the operation of cargo ships that will not receive mail compensation.

The S-4

SELDOM has there been a more flagrant example of the regrettable tendency of our daily press to assume the role of both judge and jury, to pronounce judgment with half knowledge of facts and to fly into print with such misleading statements and opinions as can only arise from dense ignorance of facts

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and their significance, than that offered by its reports of the sinking of the submarine *S-4*.

Were it not for the suffering that such tragedies cause, both to those whose relations and friends are lost and to those unjustly blamed and condemned while doing their utmost to accomplish rescue, the advice and judgments of the papers would be laughable to anyone with the slightest knowledge of ships and of the conditions surrounding a sunken vessel. As it is, they cannot be too strongly condemned. It is, perhaps, too much to hope that the papers will forego any opportunity for sensationalism, but at least one might hope that the better of them could restrain themselves sufficiently to reserve judgment until facts are known, and to leave the expression of opinion and advice to those whose knowledge and experience qualifies them for such expression.

Submarines are a very special class of vessel; the average seaman and navigator knows little, the general public practically nothing, of their peculiarities, the methods of operating and controlling them, or the possible means by which they may be raised to the surface if disabled and sunk. Nevertheless, the papers were filled with suggestions of their own and of zealous correspondents, all of which were given "front page" space—the general result being that the public was led to believe that the whole operation of attempting to raise the *S-4* was botched and mismanaged in about every possible way, and that the Navy, in not at once accepting the gratuitous advice of the press, was criminally negligent.

Admitting that the advice was well-meant, at least in some cases, its utter futility was, in practically every instance that came to the writer's notice, perfectly apparent to anyone having even a rudimentary knowledge of ships. One example will serve as a fair sample of the value of the suggestions put forward. In effect it was this: Cut a hole through the bottom of any of the first-class battleships, pass a cable around the sunken vessel, attach the ends of the cable to the battleship's propeller shafts, and go ahead with her engines. The submarine would immediately be brought to the surface! Nothing could be simpler, more expeditious or effective! Comment on such drivel is a waste of time, but yet it was just this sort of thing which caused untold anxiety and suffering, and brought to able and conscientious naval officers damaged reputations and entirely unmerited censure and blame.

When one considers the way in which such matters are, in general, handled by American newspapers, the present instance is not surprising. It can only be taken as one of the unfortunate results of our manner of handling publicity; but that a naval court should, in effect, play into the hands of the sensation mongers, as appears to have been the case, is inexcusable. The findings of the *S-4* Court of Inquiry are, to put it the mildest way, most peculiar and regrettable—we can only trust that Secretary Wilbur will insist on a most thorough and searching carrying out of his order—that it review its proceedings and explain its findings with "particularity."

Dry Docking

IN A RECENT communication from a gentleman indirectly interested in the operation of a fleet of coastwise steamers the question was raised as to the period of dry docking usually observed with ships in the coastwise trade. The answer, in this instance, based on experience with a particular fleet of vessels, was "once a year for the larger ships and every six months for small steamers which navigate to a large extent in shoal water and over sandy bottoms."

There is nothing unusual in either question or answer and it is believed that the latter conforms with what is generally considered safe and conservative practice for seagoing as well as for coastal vessels. In the vast majority of cases an annual docking is all that is necessary to keep an operating vessel in fairly good condition, so far as her underwater body is concerned. But there are not infrequent instances among steel vessels calling regularly at certain ports, and with vessels which happen to be laid up for any considerable periods in these ports, in which apparently good bottom condition when coming out of dry dock is by no means a guarantee that considerable or even very material damage may not be sustained in less than twelve months' time.

Of course, where shallow channels have to be regularly negotiated, in which tidal flow and the drag of the ship in passing over sandy bars or shoals causes a good deal of sand to be picked up and carried along by the water itself, as is the case with the small steamers previously referred to, the necessity for more than ordinary care is obvious enough and is recognized as a regular and necessary factor in the problem of maintenance. For larger vessels, particularly when docking regularly in the ports of great manufacturing and industrial centers, there are other destructive agencies to be guarded against which, because of their obscure working, are recognized far less generally than the purely mechanical action of sand and similar material on bottom paint. Sewerage, particularly that produced by certain types of industrial plants, contains more often than not considerable quantities of acids or at least is capable of contributing to acid reactions destructive both to paint and to the steel which it covers. While the exact composition of these chemicals is naturally variable, experience in some cases seem to indicate that certain of the most destructive combinations have a density somewhere between those of fresh and salt water and as they evidently possess a certain degree of cohesion they will, if left undisturbed in a body of water fresh at the surface and salt at the bottom, form in a layer at some intermediate depth. The water in many harbors at some distance from the

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open sea, particularly in those situated on or near the mouths of large rivers of fresh water, nearly always conforms to the characteristic above mentioned—it is often very nearly fresh at the surface and quite salt near the bottom. Experience with several large steel vessels indicates that when this condition obtains, strata or layers of various chemical solutions are found below the surface, the depth varying according to the density or specific gravity of the particular chemical in suspension in the water. These particular ships had alternating periods of service and lay-up totaling something over a year after launching. At the first dry docking it was found that the rivet points in three strakes of plating, starting approximately three or four feet below the surface forward, extending down around the bilge amidships, and then aft to a point some distance below the surface at the stern post, had been badly damaged and in many cases almost entirely destroyed. The remainder of the shell plating, both above and below the bilge, was in practically perfect condition although all paint had disappeared. While this experience of course does not prove the truth of the theory outlined, the fact that the ships had, for some months previous to docking, been anchored in water fresh at the surface and salt below, and in the neighborhood of some large chemical works, at least makes the theory a plausible one.

Another cause of bottom trouble, a comparatively modern development, is the effect of copper bearing steel upon ordinary steel rivets, when immersed in salt water. This is a matter which has already been discussed at some length in these columns. The increasing use of copper-steel in structural work is having its effect on ordinary ship steel, copper bearing scrap from the former evidently finding its way into the latter. There can be but little doubt that this is a principal cause of the many cases of extensive bottom damage which have occurred, particularly in this country, during the past few years.

Although an annual docking is usually considered and probably is all that is necessary in the majority of cases, the particular instances of damage due to water conditions which have been mentioned, and the apparently increasing probability of trouble arising from electrolytic action between ordinary steel rivets and shell plates containing an appreciable amount of copper, indicate rather clearly that undue extension of docking periods may prove a serious matter.

To dry dock a large vessel more frequently than once a year would certainly appear to most shipowners an abnormal increase in operating expenses and indeed should be unnecessary, provided those agencies which tend to cause trouble are fully realized and guarded against both in the building of a ship and in caring for her after she has gone into service. A very large part of all bottom trouble it appears certain, can be successfully met by the use of pure iron rivets in such parts of a ship's hull as are constantly in contact with salt water. Steel rivets with a large copper content are also being experimented with, having the same purpose in view, but so far have not yet been used to any great extent. Finally, when the ship is in operation, too much care cannot be devoted to bottom paint, both as to quality and method of application. Too much painting is done as a matter of routine, with little or no thought of the results obtained. Painting a damp or foul bottom is but a "gesture of maintenance." This is not only a waste of paint but is the basis of an entirely false sense of security and yet this practice too often obtains among people who should know better.

Stability Problems

THERE is perhaps no other quality of a ship more misunderstood by the layman and even by many of those who "go down to the sea in ships" as their regular occupation, than stability. While the principles which underlie the forces which keep a ship right side up are, in themselves, simple enough, the fact that the ship in service is a moving body, that she is supported by a fluid furnishing only vertical and not lateral support and can only maintain an upright position in that fluid by relations of weight and volume entirely within herself, serves to make the actual application of these simple principles a rather difficult matter for the uninitiated to understand. Moreover, as the action of the fluid-supporting force is almost constantly varying, simple statical balance seldom, if ever, *completely* exists, even when the ship is in port. The action of the floating vessel while, in the main, controlled by so called statical conditions is very largely a matter of motion or dynamics.

The most common and the most natural mistake is the idea that a stiff ship offers the greatest resistance to rolling. Such a vessel does offer the greatest resistance to inclining, but inclining and rolling are, unfortunately, two very different matters. However stiff the vessel, she cannot avoid being inclined by waves and her very property of stiffness serves to bring her back quickly and forcibly so that rolling is at once set up in much greater and more uncomfortable degree than with a less stable ship. At the other end of the scale is the circular log, which has no positive stability or tendency to right itself and floats in a neutral condition with no proper top or bottom. The stiff ship is practicable; a circular, homogeneous vessel, of course, is not, but nevertheless too much stiffness may be nearly though not quite so dangerous as too little. For every service there is a *best* degree of stiffness, depending on character of cargo and loading and the weather and seas which the ship is likely to encounter in her prescribed trade. Like everything else involved in ship design, its determination is a matter of compromise of conflicting elements which calls not only for scientific knowledge, but for extended experience and sound judgment as well.

Another stability question, often misunderstood, and where symptoms, more often than not, are misinterpreted, is the effect of the rudder on heeling when a

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ship is in more or less rapid motion. The heeling of a ship by its rudder is dependent in the main upon two things; the metacentric height of $G\ M$ and the vertical position of the metacenter and center of gravity, which fix this $G\ M$ with reference to the center of effect of the rudder area and the center of lateral resistance of the hull. This second condition is often overlooked, but in large passenger ships with a lofty superstructure and small $G\ M$ particularly in the bay and sound types of passenger carriers and in very high speed ships, such as destroyers, it has a very considerable and sometimes very unpleasant effect. Anyone who has been aboard a destroyer maneuvering at full speed has had physical and occular demonstration of this phenomena.

When the helm is first thrown hard over and before the ship commences to turn appreciably, a couple is set up by the rudder pressure and the weight of the vessel as concentrated at her center of gravity. In other words, the pressure on the rudder tends to push the bottom out from under the top of the ship, in consequence of which she heels inward or towards the side to which the rudder is turned, often very sharply. About the time when one becomes adjusted to this condition of things, a new force comes into play in a most disconcerting manner. As the vessel starts to turn, her weight, again as represented by the center of gravity, tends strongly to keep on in its original direction, straight ahead, and at once a new couple is set up in the opposite direction, between the aforesaid center of gravity and the center of lateral resistance or of water pressure against the immersed side of the ship away from the direction of turn. The result is that the vessel heels more or less suddenly and deeply in the opposite direction, this final heeling being to some extent maintained until the helm is righted and the ship again proceeds straight ahead.

To one previously unacquainted with this rather startling performance, the most natural explanation is a deficiency of metacentric height. While it is true that a large $G\ M$ will tend to increase the amount of heel caused by the rudder, the vertical height of the center of gravity above the rudder is the controlling factor and the sudden inward and outward inclinations will take place, regardless of the vessel's stiffness; in fact an excess of the latter may cause the ship to almost "flop" from one position to the other.

In commercial vessels of more moderate speed, no such sudden and uncomfortable antics are produced by rudder action, but the tendency is present, nevertheless. Where the ship's center of gravity is located at a considerable height above the center of effort of the rudder, very appreciable heeling, followed by rolling, is often in evidence when the ship is being navigated in restricted waters or among other vessels in a harbor or roadstead. Such action is often attributed to lack of stability and the writer has in mind several successful and perfectly stable and safe coastwise steamers which have earned an entirely unfounded and erroneous reputation for tenderness because of their rather excessive heeling and almost constant rolling motion when being manoeuvered through the crowded waters of New York harbor. As a matter of fact a little more $G\ M$ would have gone far to correct this fault, but the ships have, from every other point of view, all the initial stiffness which is necessary for satisfactory operation.

Another misapprehension in regard to stability is the not uncommon belief, particularly among seafaring men, that bilge keels increase stiffness. Here again statical and dynamical conditions are confused, for while the bilge keels undoubtedly tend to decrease the range of rolling, they cannot prevent its taking place, nor have they the slightest effect upon a ship's ability to resist a statical heeling force or couple.

A somewhat similar misunderstanding relates to the "winging out" of weights and its effect upon a ship's behavior at sea. Stowing weight away from the center line and near the ship's sides increases her rolling period and her power to initially resist the tendency to roll, but so long as the vertical position of the weights remains unchanged, this lateral change in location can have no effect whatever upon her $G\ M$ and initial stiffness. All of which leads back to the erroneous notion that a ship which rolls but little and that easily, is a stiff ship. More often than not, she is quite the reverse.

So far the stability question has been dealt with from the view point of the practical ship operator rather than from that of the scientifically trained designer. Such errors as have been mentioned are to the latter perfectly well known and understood, but there is a very considerable number of his fraternity who, in the writer's opinion at least, cling to a belief which is equally open to question; that great metacentric height is of itself a bad thing from the viewpoint of seaworthiness, and passenger comfort and safety. While it should be readily admitted that excessive $G\ M$ has no place in a seagoing vessel, the practice of so designing such vessels that in certain service conditions they have no, or even in some cases negative, initial stability without ballasting seems hardly susceptible of a reasonable explanation. This is particularly true in view of the fact that some of the most successful and popular liners in service today have ample positive metacentric height, even when "flying light."

Both from the point of view of the practical operator and of the scientific naval architect it would seem that the whole subject is worthy of deeper and more consistent study and attention than has ordinarily been given to it. The misconceptions of the former would be easily corrected by a little study of almost any good, elementary work on theoretical naval architecture. This is an absorbing subject and would seem a mine of interest and information to the practical man, once he had broken through an apparent outward crust of dryness and mathematical expression. For the latter, one can but advise an occasional turning away from the beaten path of precedence and routine to get a better view of what others have successfully accomplished in the field of naval architecture.

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Merchant Marine Hearings

Recommendations made before the House Committee on Merchant Marine and Fisheries by shipowners, shipbuilders and business interests

DURING the past month the views of shipowners, shipbuilders and various business interests have been presented at hearings before the House Committee on Merchant Marine and Fisheries which is considering the various shipping measures which have been introduced at the present session of Congress, including the Jones bill, which was passed by the Senate on January 31, and the Wood bill and White bill, both of which have been introduced in the House. On behalf of the American Steamship Owners Association, the Pacific American Steamship Association and the Shipowners Associaiton of the Pacific Coast Mr. H. B. Walker presented the views of the shipowners. He said in part:

On January 1, 1928, according to Shipping Board statistics, the United States had 541 passenger and general cargo vessels with a total gross tonnage of 3,094,646, employed in the foreign trade. Four of these vessels, two passenger and two general cargo, with a tonnage of 24,446 belonged to the Panama Railroad Company, owned and operated by the Government. Of the others, 237 with a tonnage of 1,225,594 were privately owned and operated, and 300* with a tonnage of 1,844,607, were owned by the Government and operated either directly or indirectly by the Shipping Board.

As to Privately Owned Vessels

Generally speaking, we have two classes of privately owned vessels, namely, combination passenger and cargo ships and general cargo ships.

Combination passenger and cargo ships are generally making their expenses but fall far short of making enough more to assure their replacement. Immediate operating necessities of such lines would appear to be taken care of by the long term mail contracts provided for by Title III of the White bill. The present year-to-year contracts, while very helpful, do not permit the shipowner to plan ahead as he should. The policy of encouraging by liberal long term mail contracts the establishment and improvement of fast, regular and frequent service by superior ships available for naval auxiliary service has so effectively proved its usefulness in American shipping history that we assume Congress will modernize it along the lines of legislation proposed.

The future problem of these lines which consist of the types of vessels most useful to national defense is that of replacement and the successful operation of the new and more costly ships. Most of these ships have a good many years of life left so they need not all be replaced in the immediate future. In certain cases these lines, in order to meet competition and to show their serious purpose to hold their position, will require to provide new tonnage in the immediate future but this would seem to be covered by the provisions of the White bill including long term mail contracts and low rate construction loans.

Privately Owned Cargo Ships

The problem of continued operation of privately-owned cargo ships is more difficult and this class of shipping may be divided into the two following groups:

1. Lines operating tonnage purchased at low prices on easy terms from the board and now being operated on designated services which the owners guarantee to the board they will maintain for five years from date of purchase. These ships were sold by the Board at prices well below world market values. The fixed charges for interest, depreciation and insurance are, therefore, lower than on the foreign vessels with which they compete and this largely offsets the higher operating costs of American ships. It is this factor and the greater economies and larger earnings effected under private operation that has enabled private interests to buy services which were showing actual losses during Government operation. But not all private owners in this category have been able to operate without loss. And so aid through mail contracts has been accorded to some of them. As with the passenger lines none of these lines is making enough to replace out of earnings.
2. Lines mostly established for many years, operating pre-war tonnage and tonnage acquired at high cost during or after the war.

These lines occupy the more fruitful trades and their long established position is a favorable factor but they have high fixed charges for interest, depreciation and insurance and their operations fall far short of leaving enough for replacements.

We cannot help feeling that undue stress has been laid upon the necessity of our immediately entering upon a large program of new construction. New ships should be designed and built according to the needs of each trade. However, substantially all of these cargo ships will come close to being worn out within 10 to 12 years, so that provision must be made for practically their entire replacement by that time. In the next few years, therefore, the need of general replacement, if we are to place our merchant marine on a permanent basis, will be a growing one and should be provided for by far-seeing, constructive legislation.

Cost of Replacements

Getting down to the actual costs which now confront the man who wants to build a ship in this country, we have the following situation as disclosed by the shipbuilders:

The cost of building a steam driven ship of 10,000 deadweight tons would be $125 a ton for a 10½-knot vessel, $150 a ton for 12 knots and $171 for a 14-knot vessel. For the same size vessel equipped with Diesel engines, the estimated cost would be $145 a ton for 10½ knots, $174 for 12 knots and $215 for 14 knots.

It is clear from the foregoing that it would cost an American private owner or the Shipping Board approximately $1,710,000 to build a steamship, and $2,150,000 to build a motorship of 10,000 tons in an American shipyard at the present time.

On the other hand, Captain Dollar, for comparative purposes, recently asked for a bid from a British yard on a 13-knot, 10,000 deadweight ton Diesel engined ship and was quoted a price of $72 a ton.

* The Shipping Board sold 39 of these ships and 3 services to Pacific Coast interests on February 16, 1928.

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The annual fixed charges for the first year on the American vessels would be $256,500 for the steamer, and $322,500 for the Diesel ship, as against $108,000 for the British Diesel ship. Obviously, these excess charges would have to be made up from some additional source of income than that enjoyed by the vessels now operating. So long as freight rates are made by the competition of foreign vessels of lower capital costs, rates cannot be increased by an American owner sufficiently to meet the difference in the fixed charges. The American shipowner must be assured of the necessary additional income from some source.

Government Aid Required

So far as American shipowners can see, this added cost of construction in American yards can only be met through Government aid in some form, and this is true whether the Shipping Board builds the vessels and pays the whole cost of such new construction, or aids the private owners and only contributes a part of the excess costs.

American shipping interests do not believe that the provisions of the White bill as now drawn will provide the aid necessary to make possible new construction unless costs are reduced more than now seems possible. The only aid for new construction which the White bill provides is the loan of money from the construction loan fund at 2½ percent per annum on 75 percent of the cost of a new vessel. Something other than this aid must be provided if shipowners are to build in this country new, high speed, Diesel engined ships to replace the ships now operating.

Because of these conditions we believe that the Wood bill, providing for absorption of the difference between American and foreign construction costs by the Government, embodies necessary legislation, for it would place American shipowners on a parity with their foreign competitors so far as capital costs of new construction are concerned. It is for this reason that the principles of the bill are approved by the shipping interests.

Differential in Operating Costs

There is a further factor of costs which requires consideration, and that is the difference in the operating costs of American as compared with foreign ships. This is largely a matter of wages and subsistence of crews. Statistics compiled from records furnished by the Shipping Board show that the monthly wage and substenance cost of a 9,000-ton American ship is $4,041 as against $2,690.42 for a British ship, $1,581.99 for an Italian ship, $1,425.29 for a French ship, and $1,371.58 for a Japanese ship.

These differentials are being met by some of the lines already sold by the Shipping Board, through reduction in fixed charges due to low capital costs. Obviously, however, if American shipowners are to build new ships with the higher fixed charges due to larger capital costs, then these differentials in operating costs become outstanding factors which must be taken into consideration. This element of cost can be met under the provisions of title II of the White bill so far as they apply, but the provisions of this title may not be broad enough to provide the aid to the ships now operating in guaranteed services where replacements will be required during the guaranteed period of service.

Changes could be made in title II of the White bill so as to make the character of aid therein provided available to meet the situation suggested if and when such aid was found necessary by the Shipping Board.

The Shipping Board has disposed of all of its services operating out of Pacific Coast ports so that Government ownership on the Pacific is at an end, except as to those ships which begin their voyages at Atlantic coast and Gulf ports and are trading with the Far East.

As to Government Owned Vessels

The Shipping Board is, however, operating out of Atlantic Coast and Gulf ports 20 services in which it is employing 244 ships. It is said upon reliable authority that some of these services could now be disposed of if the Shipping Board would offer them for sale. In one service, however, early replacement of at least two ships seems advisable to meet the competition of British ships now building for the trade.

The services which can be sold have been brought to a state of efficiency and development, other than in the special case just mentioned, when they can probably be operated and the differential in operation costs met, provided the ships are sold at prices comparable with those accepted for other similar vessels.

None of these ships, however, is earning or can earn sufficient to make replacement possible out of earnings.

The remaining services operated by the board would seem not to have been developed to the point where they can be sold at any price and the differentials in operating costs met, even though all fixed charges on capital were entirely eliminated. It is manifest that no private owners could be expected to buy services showing such losses and the only course open seems to be for the Shipping Board to carry on, but this should be done on the most economical and efficient basis possible.

Change in Operating Management

Ever since the Shipping Board commenced its operations it has been, and at the present time is, operating its vessels by employing operators paid commissions based on gross earnings, without regard to net results. The shipping interests approve of title II of the White bill because it proposes to change this system. Instead of paying a commission on gross earnings with the Government taking the losses, the White bill proposes to pay a fixed compensation for the operation of the service over a period of years, the operator to bear the losses. This price will be fixed by public bidding. If the bidder has his own ships to carry on the service he may use them. On the other hand if he needs ships from the Shipping Board, the bill makes provision for their sale.

In short, the White bill will substitute an efficient method for the operation of the services, instead of the present inefficient and most costly system. It is similar to the substitution of a fixed price under public bids for a cost-plus system.

The situation with respect to these ships, so far as concerns replacement is essentially the same as exists with the privately owned cargo vessels. The ships in the unsold services and the ships on the sold services stand on substantially the same basis. They are not earning their replacement costs, and the burden of replacement has got to be borne by the Government.

If the Shipping Board does not sell the services, but replaces the vessels as and when required, all the costs of replacement will be borne by the Government. If the principle of the Wood bill is adopted, and properly modified with safeguards, then only part of the cost of replacement will be carried by the Government. The balance of the burden will fall on the private owners. This latter course would seem to be good business for the Government.

If the principles of the Wood bill, or of some similar measure, are not enacted into law, and if the Government undertakes a replacement program as apparently

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the Jones bill contemplates, and the Government again enters upon a renewed period of Government ownership and operation with newer, larger, faster ships in essential services, we shall see history repeat itself. With foreign private owners having in the future equally as good and economical ships as the Shipping Board would possess under any replacement program, there would be no reason to expect that Government ownership and operation would prove any more successful than it has in the past. Continuance of the Government in the business would surely involve the country in continued operating losses.

The statement of present construction costs submitted by the shipbuilders shows that the replacement of the ships being operated by the Shipping Board could well involve an ultimate expenditure of the stupendous sum of $525,355,000, and added to this would follow the enormous losses from continued Government operation.

We respectfully submit that it would be more conservative and better business judgment, if the essential provisions of the Wood bill, with modifications and amplifications, were carried into the White bill, and the aids provided for in both bills were combined in the bill which ultimately issues from this committee. If this constructive legislation is enacted, you will quickly see the services now being operated by the Shipping Board transferred to private ownership in the communities served by the respective lines, and all American shipping placed on a permanent basis. Orders would be placed in American shipyards for new vessels, and a general period of prosperity in the shipping industry would follow. This would inevitably result in an increased development of our foreign trade. Nothing so much as this legislation would arouse the general interest of the country in an American merchant marine, place it on a permanent basis, and convince our foreign competitors that we are on the sea to stay.

Shipbuilders Suffer From Lack of Work

Using for illustration a $15,000,000 ship of the *Leviathan* type, Mr. H. G. Smith, vice-president of the National Council of American Shipbuilders, testifying before the Merchant Marine and Fisheries Committee of the House of Representatives, demonstrated that the material necessary for the construction of a ship in an American yard today would require materials from all but four states of the Union. Direct purchase by the shipbuilders include raw materials and manufactered products.

The total amount for direct purposes by the shipbuilder on the $15,000,000 ship is about $7,500,000, and of this amount Pennsylvania furnishes the largest share of any of the states. For iron and steel, glass, paint, and tools, Pennsylvania industry receives more than $2,000,000 for its part in the construction of such a ship.

New Jersey is the second state on the list in value of parts and material furnished and obtains about $1,200,000 for boilers and machinery.

New York is third, and provides electrical equipment, furniture and carpets and other material to the value of $1,110,000.

Other states contributing a large proportion of material for the new ship are Massachusetts, Ohio, Michigan, Connecticut and Indiana.

Emphasizing the fact that the same nation-wide benefit to industry is afforded by the building of medium sized vessels as well, Mr. Smith called attention to the present greatly depressed condition of the shipbuilding industry and urged the need for building up a modern fleet of fast passenger-cargo vessels for world trade.

It was pointed out that since 1921 the United States has experienced a continuous decline in shipbuilding. Unfinished war contracts for both the Navy and merchant Fleet Corporation maintained fair activity in the shipyards until 1921. From that time on the amount of shipbuilding in the United States has been less each year than during any pre-war year since 1897. In 1927 Great Britain launched one million and a quarter tons of shipping, half of the total tonnage in the entire world. The United States launched 125,000 tons, and not a single ship was built in this country for foreign trade. Germany has built during the last five years three times as many ships as have been launched in the United States.

Mr. Smith also made it clear that this shipbuilding depression has disastrous and far-reaching consequences on prosperity in the United States generally. Showing that we were enabled to launch so quickly and successfully a large number of ships during the war due to the fact that the shipbuilding industry had been greatly stimulated for two or three years previously by the withdrawal of foreign vessels from American trade at the outbreak of the World War, Mr. Smith emphasized the fact that the technical and mechanical staffs and shipyards facilities, that were available when needed in 1916 as a result of the World War impetus, no longer exist.

U. S. Chamber of Commerce Indorses White Bill

Enactment of the main provisions of the White merchant marine bill, as offering the promise of establishment of American shipping, was urged on the House of Representatives by Lewis E. Pierson, president of the Chamber of Commerce of the United States.

In a communication to members of the House, Mr. Pierson declares that American business is convinced that only a privately owned and operated merchant marine can serve permanently the country's shipping requirements. His letter reads:

"The Chamber of Commerce of the United States earnestly urges passage of legislation to provide an adequate privately owned and operated merchant marine. The White bill embodies provisions which the National Chamber through resolution and referenda believes necessary to carry out this purpose. It sees in this measure more promise for the upbuilding of American private shipping than has appeared in any legislative proposal in recent years. The Chamber hopes that this bill, or the principles it contains, with the exception of Title V, may be substituted for the Jones bill as recently passed by the Senate.

"It is the firm belief of the National Chamber that only a privately owned and operated merchant marine can serve permanently the shipping requirements of America.

"The bill as passed by the Senate will continue the government indefinitely in the operation of our merchant fleet. Such a policy is not sound nor is it the only alternative to having the American flag disappear from the seas.

"The provisions of the White bill contemplate inviting bids of private ship owners in open competiton for mantaining the trade route services determined by the Shipping Board as essential to our foreign trade and national defense.

"Congress in the Act of 1920 directed the Shipping Board to determine what steamship lines should be established for this purpose. If responsible citizens could not be found to supply the necessary services the board was directed to operate vessels on such lines until the vessels could be sold.

"These public policy services are now largely being carried out at the cost of many millions of the taxpayers' money each year due to deficits incurred by Shipping Board operations. The National Chamber believes that the contract method provided in the White bill will furnish better service and at much less cost to the taxpayers than now is entailed. The Chamber therefore strongly supports these provisions of the bill.

"There are many precedents for the government entering into trade route contracts which are in the public interest. Air mail contracts, the construction of highways are all charged against the government for they are considered essential in the public

(Continued on page 227)

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Main stairway

Well over cabin dining room

Writing room

Children's playroom

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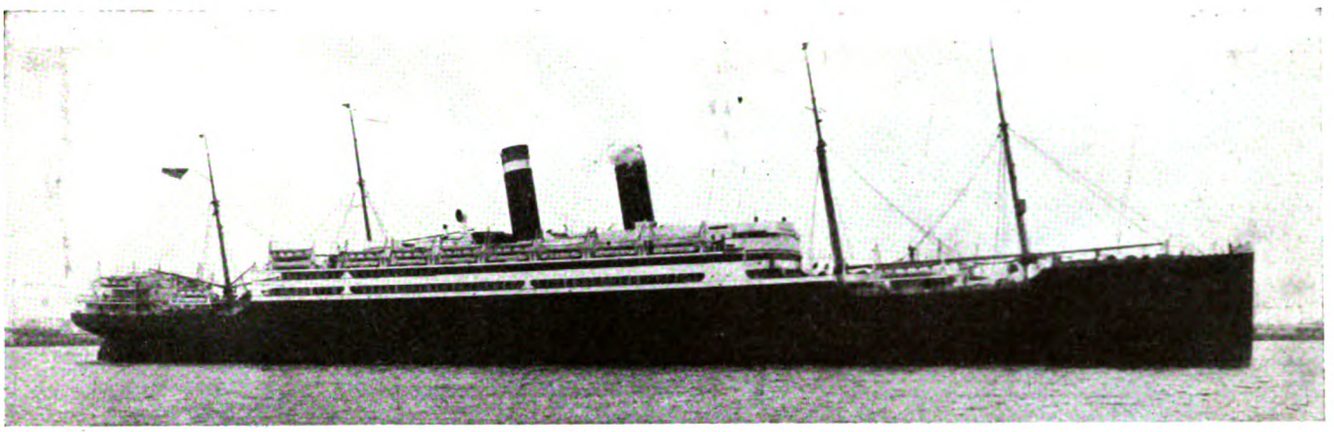


United States Lines cabin liner America

The Passenger Steamship America

Reconditioned by Newport News Shipbuilding and Dry Dock Company for United States Lines

By Carl E. Petersen

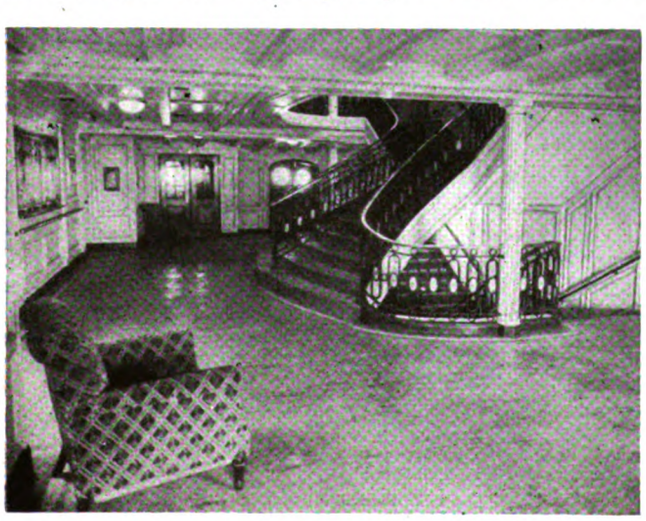
WHEN in the spring of 1926, after having undergone annual overhaul preparatory to reentering the transatlantic passenger, cargo and mail service, the *America* was partially destroyed by fire, the United States Lines suffered a severe loss and its service was badly handicapped by the elimination from service of this crack cabin liner with its unequaled reputation among the ocean-going traveling public. The vessel sustained damage so extensive as to preclude its restoration in time to take part in that year's passenger season. The United States Shipping Board awaited the outcome of the proposals for the sale of the United States Lines and the American Merchant Lines before finally authorizing the work of rebuilding and reconditioning the vessel to be undertaken. This was done early in 1927 and the contract for the general reconditioning was awarded to the Newport News Shipbuilding and Dry Dock Company, Newport News, Virginia. This work has been completed and the vessel reentered service, sailing from New York March 21. So out of the fire has arisen what is perhaps the finest cabin and tourist class passenger liner in the North Atlantic service, the "new *America*."

The *America* is a steel twin screw passenger and cargo steamer, having 5 full length principal decks in the hull and 3 superstructure decks, also 4 masts and 2 funnels. She has a slightly forward raked stem, a counter stern, a complete double bottom and 12 watertight subdivisions. She was built by Harland and Wolff, Belfast, Ireland, for the Hamburg-American Line to the requirements for the highest class of Lloyd's Register of Shipping and the Germanischer Lloyds, but is at present classed in the American Bureau of Shipping.

The principal dimensions and particulars of the *America* are as follows:

GENERAL INFORMATION

Service—New York-Plymouth, Cherbourg and Bremen.
Builder—Harland and Wolff, Belfast, Ireland.
Rebuilt by Newport News Shipbuilding and Dry Dock Company, Newport News, Va.
Owner—United States Shipping Board.
Operator—United States Lines.



B deck lobby

C deck lobby

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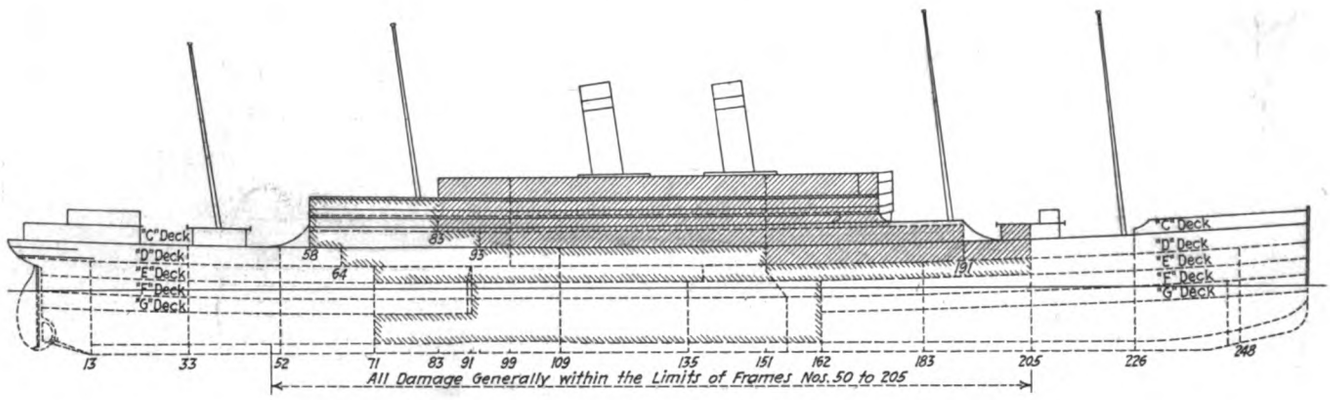

Profile of S. S. America showing extent of fire and water damage

CHARACTERISTICS

Length overall	687 feet
Length between perpendiculars	669 feet
Breadth, molded	74 feet 3 inches
Depth, molded	52 feet 5⅜ inches
Draft, loaded	33 feet 5½ inches
Block coefficient	0.729
Service speed in knots	16
Framing	transverse
Class	American Bureau of Shipping

TONNAGES

(In tons of 2,240 pounds)

Deadweight capacity	12,560
Displacement, loaded	34,575
Displacement, light	22,015

(In tons of 100 cubic feet)

Gross register	21,145
Net register	12,257

COMPLEMENT

Total officers and crew	570
Cabin passengers	835
Tourist passengers	516
Total passengers	1,351
Total complement	1,921

LIFE SAVING EQUIPMENT

42 lifeboats accommodating 2,101 persons

BOILERS

Number	8. D. E.
Type	Scotch
Furnaces	48
Fuel	Coal
Draft	Howden forced
Total heating surface, square feet	44,000
Total grate surface, square feet	1,092
Working pressure, pounds per square inch	210

ENGINES

Number	2
Type	Quadruple expansion
Size	34 x 49 x 71 x 100 - 63
Horsepower—service	16,000
Horsepower—maximum	17,500

PROPELLERS

Number	2
Type	Built-up, true screw
Number of blades	3
Diameter	20 feet 3 inches
Pitch	23 feet 7½ inches
Developed area, square feet	106.66
Projected area, square feet	89.33
Disk area, square feet	322.06
Developed area ÷ disk area	0.3311
Projected area ÷ disk area	0.2774
Pitch ÷ diameter	1.166
R. P. M.	80

CAPACITIES

Cargo Spaces

Total bale, cubic feet	357,993
Total grain, cubic feet	393,793
Total available space for ship's stores in cubic feet	113,572

Bunkers

Total capacity at 42 cubic feet in tons	4,880.0
Total capacity at 45 cubic feet in tons	4,554.9

Tanks

Total fresh water in tons	3,945

Extent of Damage

The damage sustained by the vessel as a result of the fire was very extensive; practically the entire superstructure was destroyed. The profile of the vessel reproduced on this page, showing the general extent of the fire and water damage, illustrates by the full hatched portion the part of the vessel damaged by fire, and, by the outline hatched portion, the part damaged by water. It will be observed that practically all of the cabin passenger accommodations in the superstructure on the boat, A, B and C decks were destroyed by the fire as were the cabin dining room and the stewards' quarters immediately forward on D deck. The remainder of the damage, that due to water, included the remainder of the cabin passenger accommodations on A, C and E decks, also the tourist social hall on B deck, and the galley and pantry spaces, the tourist dining room, and the engineer officers' accommodations on D deck.

Work Done

The rebuilding and reconditioning of the vessel*, which required almost a year to complete, comprised not only the restoration of that part of the vessel damaged by fire and water but also included the entire rebuilding of the tourist passenger accommodations, facilities and public rooms, together with extensive repairs and renewals to the vessel outside of the fire-area and a complete overhaul of the boilers and auxiliaries (the main engines having been overhauled just prior to the fire).

Without burdening the reader with statistics but with a view to enabling him to comprehend the amount of work done in the rebuilding of the *America*, the following approximate figures are given: 435 tons of new hull steel, 368 tons of hull steel removed, faired and replaced, or faired in place; 47,000 square feet of new wood decking; 88,000 square feet of asbestolith floor covering; 86,000 square feet of Haskelite plywood for bulkheads; 12,000 square feet of Vehisote for ceilings; 20,000 gallons of paint; 28,000 square feet of United States Rubber tile; 8,100 square feet of linotile; 45 tons of piping of various kinds and sizes; 4,400 yards

* The structural work carried out on this vessel was described in a paper on "The Design of Superstructures for Large Passenger Ships," read by the author before the Society of Naval Architects and Marine Engineers, New York, November, 1927, an abstract of which was published on page 685 of the December, 1927, issue of MARINE ENGINEERING AND SHIPPING AGE.

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of carpet; 4,200 square yards of draperies and about 13 miles of electric cable.

Some of the striking features of the work, making the "new *America*" the most distinctive cabin and tourist passenger vessel in service, are described in the following:

Lounge

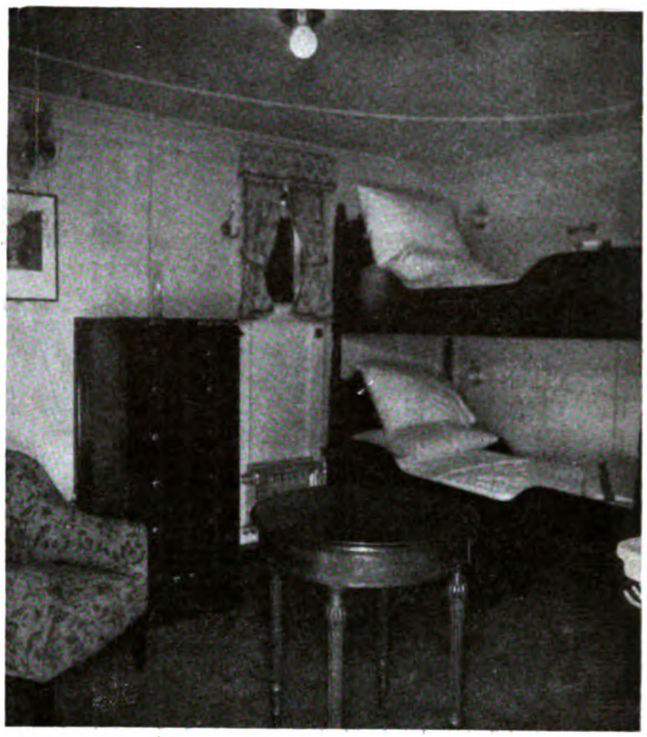
On the boat deck, the space originally occupied by the first class winter garden, with additional space at the after end, has been utilized for the cabin lounge, the design being of Louis XVI period by Messrs. Barnett-Phillips and Associates of New York and carried out by Messrs. J. C. Knipp & Sons of Baltimore. In the port after alcove of this room has been provided the library, while on the starboard forward side in the space abreast the casing is located the writing room.

These rooms are a beautiful example of the period, the woodwork is painted in three-color harmony and appropriately ornamented. The decorative scheme is carmine and green. A marble fireplace glimmering with artificial fire and a liberal number of plate glass mirrors in addition to the furniture, hangings, carpet, engravings, etc. complete the rooms.

Social Hall

On A deck, the space originally occupied by the first Ritz-Carlton restaurant on shipboard and more recently used for a cabin social hall has been restored to its former elegance with but few departures from the original design. This room is decorated in the Renaissance period. The walls are paneled with contrasting hardwoods in natural finish; chestnut, sycamore and mahogany being used for the walls with gold-plated chased bronze ormulu applied, after the style of the eighteenth century. The ceiling is neatly paneled and painted. Casement windows and a domed skylight with varying shades of amber glass give sufficient light in daytime, while numerous gold-finished ceiling lights and wall bracket fixtures provide artificial illumination. A teakwood parquet dancing floor about one-half of the area of this room covers the central portion while the remainder of the floor is richly carpeted. Rugs are also used on the dancing floor when it is not in use.

Cabin stateroom



Cabin stateroom

Comfortable furniture of mahogany and tapestry of a design to suit the period of the wall decorations has been provided by Orsenigo and the effect, while simple, is harmonious and rich. Finally, this room is of that design, character and finish rarely duplicated in modern ship appointments, the reason undoubtedly being the present prohibitive costs.

Smoking Room

One of the novel features on this ship is the cabin smoking room, which has the unusual distinction of running through two decks, the A and boat decks. The upper deck is in the form of a broad gallery with an open space in the center, allowing light from the skylight over to contribute to the natural illumination of both decks.

The room, designed by Messrs. George A. Crawley & Partner, and executed by Messrs. J. C. Knipp & Sons, represents as nearly as possible a great hall or hunting room of an Elizabethan manor house, with solid oak hand carved. Two fire places with artificial grates are provided, one on each deck, while over the lower one is a beautiful solid oak hand carved mantel.

The rooms are exceptionally well furnished, rubber tile floors, oriental rugs, and hand wrought lantern light fixtures complete the effect.

Dining Room

On D deck, just forward of the main staircase lobby, the cabin dining room is situated, occupying a space about 90 feet long by the full width of the vessel and is arranged to accommodate 352 persons at one seating, with tables generally of 2, 4 and 6 persons' capacity. The main galleys and pantries are conveniently abaft the dining room, insuring good service.

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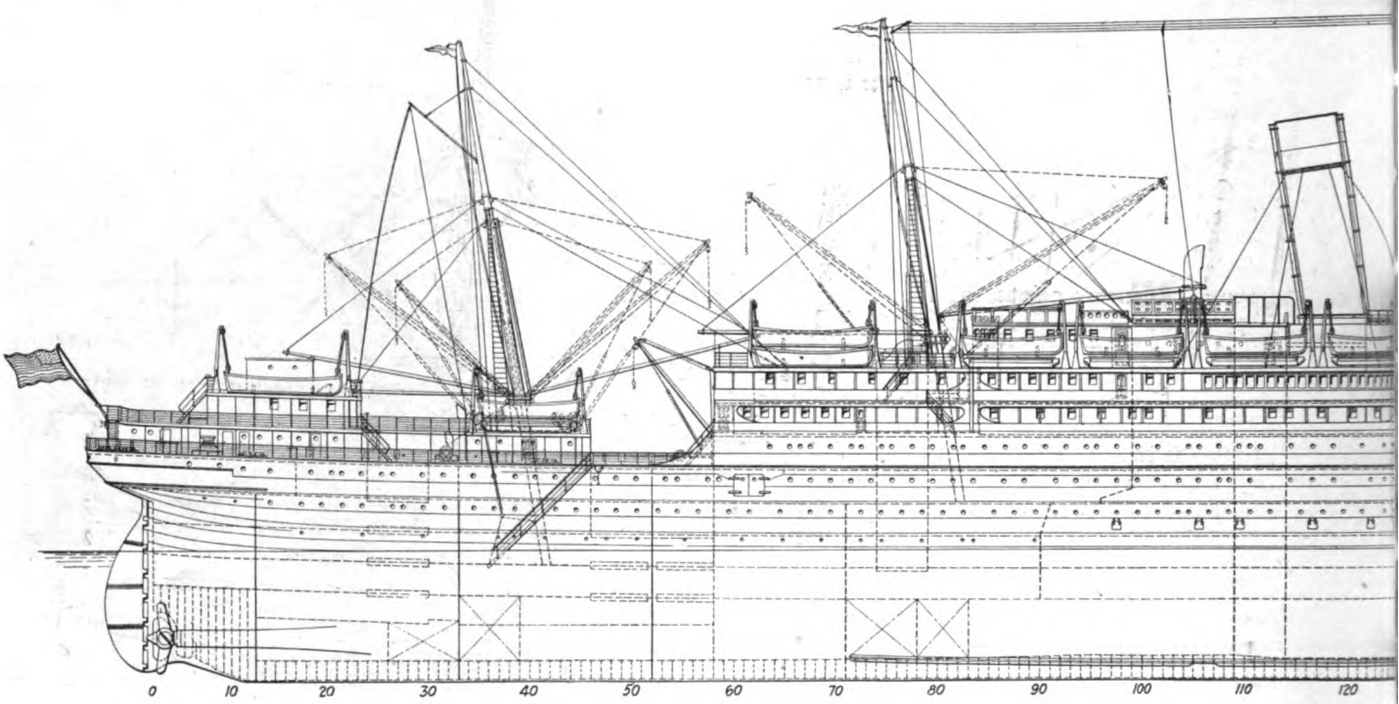

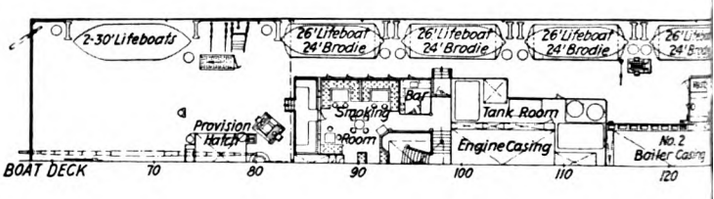

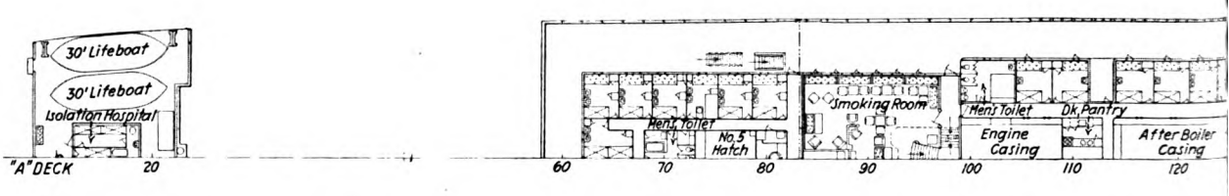

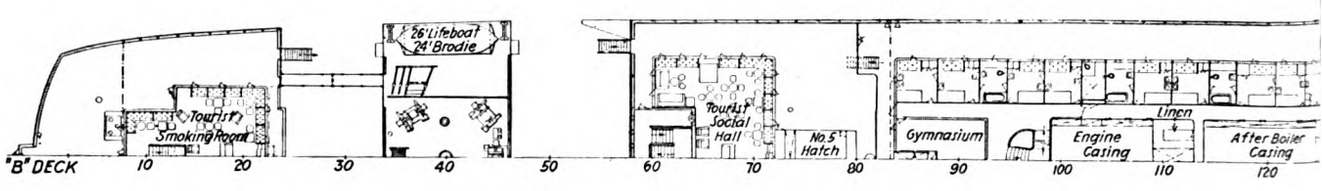

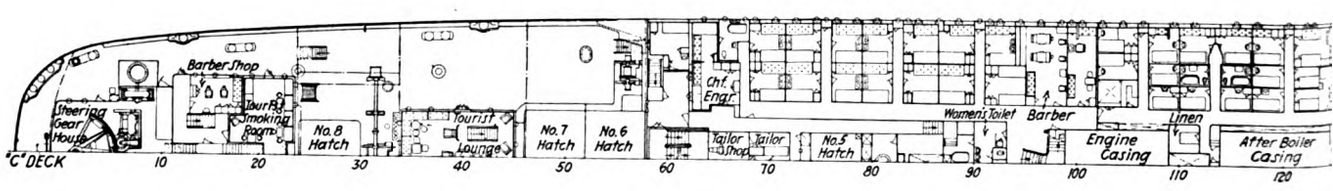

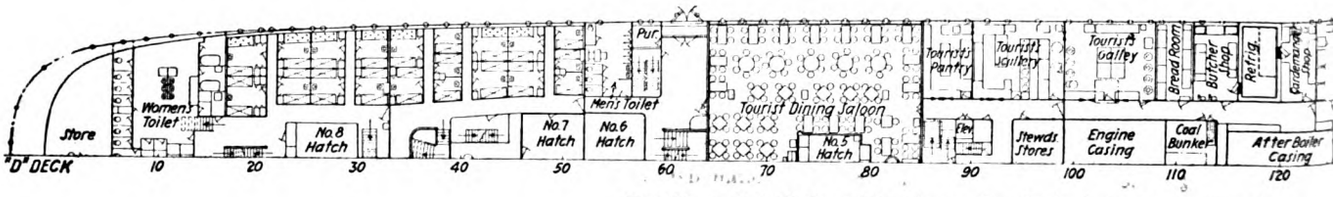

Profile and half breadth plans of principal decks of the Amer

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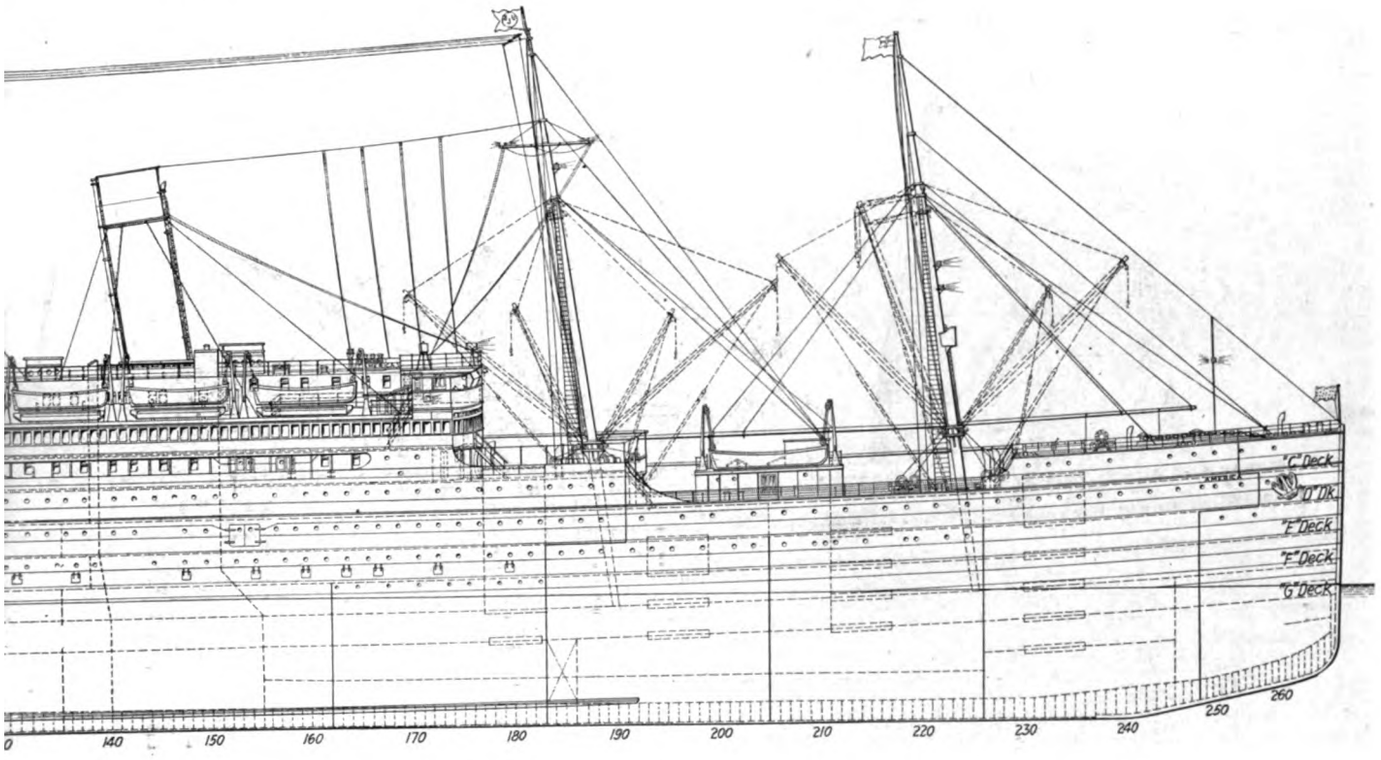

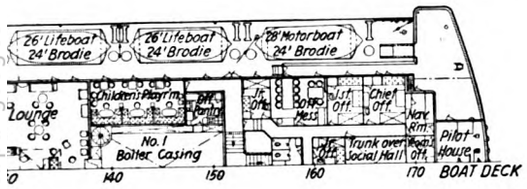

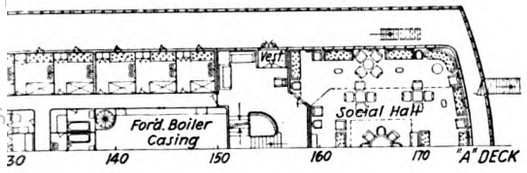

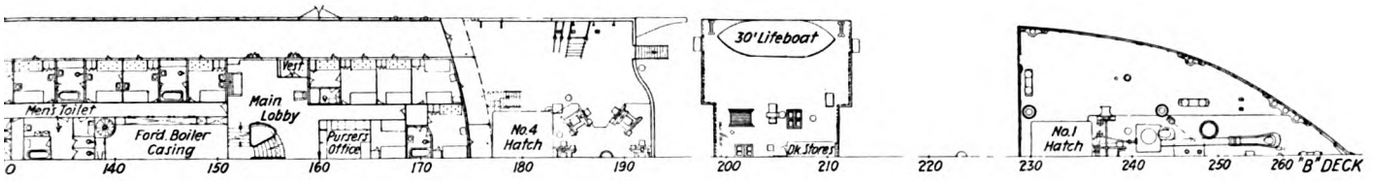

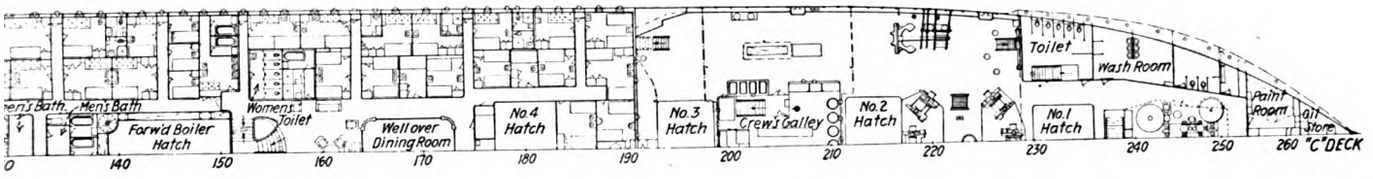

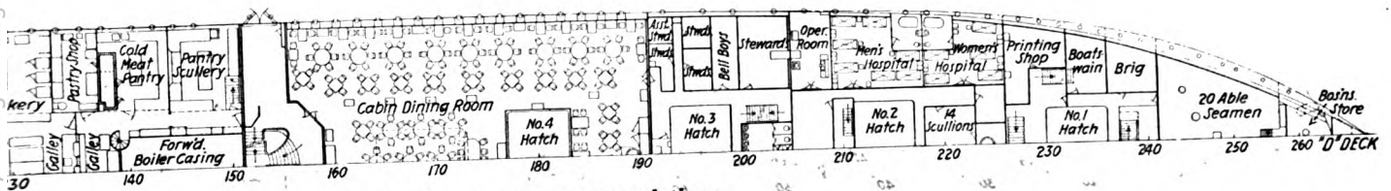

ica, showing general arrangement of passenger accommodations

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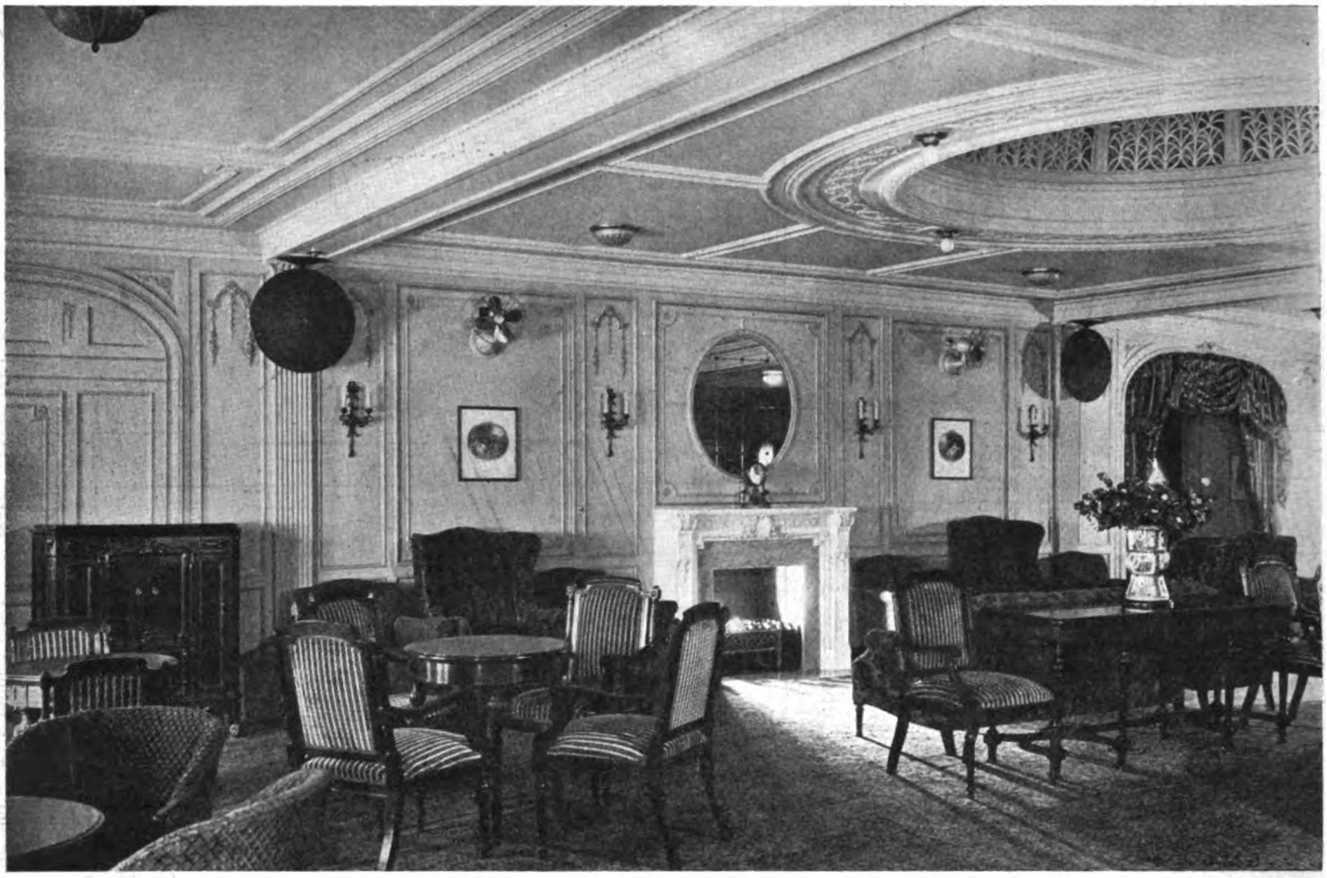

Cabin lounge

Cabin social hall

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Cabin dining room

Cabin lower smoking room

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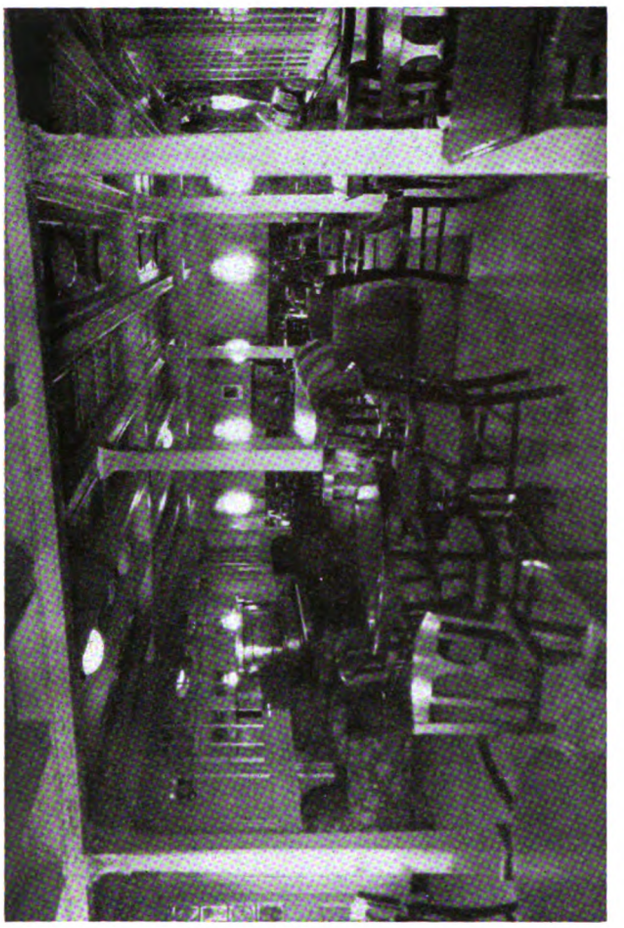

Tourist social hall

Tourist smoking room

Tourist dining room

Tourist lower smoking room

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The character of the woodwork is Colonial, finished in soft colors. Casement windows conceal the airports without excluding the light. A large well has been provided over the center of the room, giving a sense of height and space. Beautiful electric light fixtures adorn the ceiling and walls and silver combination candelabra and fern dish table lamps have been provided for each table. The deck is covered with rubber tile of marble pattern.

The dining room has been restored to the design prepared by Messrs. Walker and Gillette, architects, New York city, who also assisted in the selection of electric light fixtures and hangings and furnished the color scheme. Particular attention has again been given to the ventilation of this room which follows substantially the arrangement existing before the fire and which has been illustrated and described fully in MARINE ENGINEERING AND SHIPPING AGE, page 414, July, 1924, issue.

Other Cabin Public Spaces

In addition to the foregoing there has been provided a fully equipped gymnasium, and a unique and interesting children's playroom. An unusual feature exists in the staircases throughout the cabin spaces. The main staircases have been entirely rebuilt of steel fireproof construction, over which has been applied paneling in harmony with adjacent woodwork. The stairways are most elaborate and have very easy ascents. The metal balustrades are tastefully designed, and in cases where the stairway is broad an auxiliary balustrade is carried down the center. Throughout the cabin spaces the floors of the lobbies and passageways have been covered with marbleized rubber tile in large sheets with appropriate contrasting borders, the whole being a decided departure from the customary design and pattern.

Above the boat deck landing of the grand staircase is an oil painting of Americus Vespucci, while above the stair landing in the upper smoking room is a map of the United States, painted in oil and depicting either the history, commerce or romance of the particular place. Both of these paintings were executed by Miss Glenna Latimer, of Norfolk, Va., after considerable research work.

Unusually spacious deck promenades, both open and protected by Laycock windows, exist.

Cabin Staterooms

Cabin accommodations have been provided for 835 passengers, in 14 one-person, 92 two-person, 28 three-person, 137 four-person and 1 five-person staterooms.

Generally, each of the four-person rooms is equipped with one four-poster wooden bedstead, two high and one combination C-D sofa berth, wardrobes, two lavatories, with running water. The sofa berth, when unoccupied may be made up as a comfortable settee. The whole arrangement has such flexibility that these four-person rooms may be made to accommodate comfortably either one, two, three or four persons.

Many of these rooms are so arranged that they may be converted readily into suites with communicating doors and baths, while a liberal number have either private baths or showers. Every stateroom above E deck has been provided with beds 36 inches wide, having springs of special design and inner spring mattresses. The sofa berths are so designed as to permit a 32-inch width when used as a bed. A berth reading light has been provided for each passenger.

The staterooms generally are of Colonial design, having Haskelite for bulkheads appropriately paneled. The toilet arrangements are most modern, complete with all necessary appliances, including thermos bottles.

Tourist Accommodations

The tourist passenger staterooms, public rooms and facilities have been rebuilt entirely. There has been provided accommodations for 516 passengers, in 58 two-person, 95 four-person and 3 six-person staterooms. These rooms are equipped with four poster wooden bedsteads two-high, and in many rooms combination C-D sofa berths are also installed. Each room has a lavatory with running water, mirror and toilet accessories, electric fan, rug, etc., while many of the rooms are provided with built-in wardrobes.

The public rooms consist of a large social hall, two smoking rooms, lounge and a dining room, which is arranged to seat 274 persons at one time at small tables suitable for serving two, four and six persons. The staterooms and public rooms are unusually comfortable, complete to the minutest detail and tastefully decorated; this, together with the large promenade deck space should and undoubtedly will create a large demand for bookings in this class.

The galleys and pantries were rearranged and refitted in accordance with the latest requirements to give excellent service.

Provisions have been made to prevent fires, cause their detection and limit their spread as well as to extinguish them when they do occur. The cargo spaces are protected by the Rich system, the passenger and crew spaces have the aero-alarm detection system, and in addition firescreen bulkheads have been fitted in the superstructure above C deck, as indicated on the plans.

The Stone-Lloyd system of operating main watertight doors from the bridge has been thoroughly overhauled and the main subdivision bulkheads have likewise been put in a watertight condition.

One of the principal aids to safety is the public address system, described later, by which passengers may be informed of any untoward condition and reassured and instructed.

Navigating Equipment and Communication

In addition to the usual magnetic compasses, there is installed a Sperry master gyro-compass with three repeaters, two of which are on the bridge. There is also a Sperry gyro pilot for automatic steering, a Sperry course recorder, a Kolster radio compass, a rudder indicator and submarine signal device. Four electro-mechanical sounding machines complete the navigational appliances.

A 2-kilowatt continuous wave tube transmitter radio set has been fitted. A feature of the vessel is the public address system, adaptable to radio reception as well as for transmitting music from the ship's orchestra on C deck, abaft the dining room well, or other entertainment located in the lounge on the boat deck. Loud speakers are provided in all the public rooms in both the cabin and tourist spaces; the system is so arranged that general information and news may be transmitted from the purser's office.

A 16-station Western Electric selective talking and selective ringing telephone system has been fitted for ship's service, in addition to the Cory-Magnavox loud speaking telephone system for docking purposes and a similar system for the engine room communication as an auxiliary to the mechanical telegraph.

As in the case of many other similar jobs on trans-Atlantic passenger liners, the plans and specifications for the rebuilding and reconditioning of the *America*

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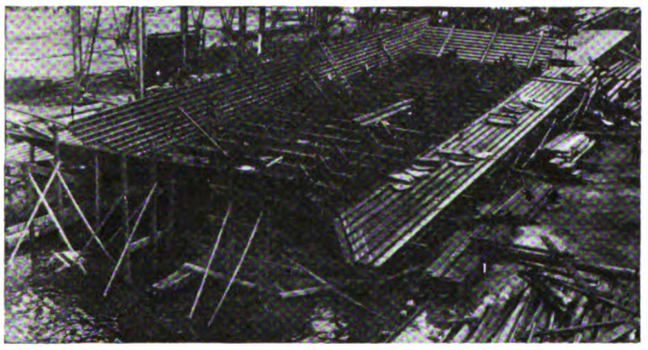
were prepared and the work supervised by the United States Shipping Board, Merchant Fleet Corporation's own staff.

The "new *America*" ranks as one of the finest passenger vessels of any class on the North Atlantic service and is an outstanding example of American talent for combining utility, comfort, beauty and charm. Only an inspection of the vessel can adequately disclose the excellent character of the work done.

Derrick Barge Monarch

WHAT is believed to be the largest sea-going floating derrick barge in the world was recently placed in commission by the Merritt-Chapman and Scott Corporation of New York. This vessel, known as the *Monarch*, was built by the Newport News Shipbuilding and Dry Dock Company, Newport



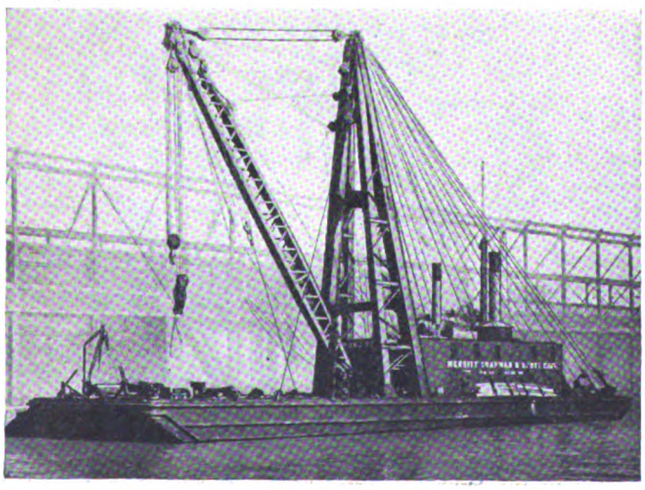
Hull of the Monarch under construction

News, Va. The dimensions of the barge are: Length overall, 156 feet; breadth overall, 52 feet; depth, molded, 13 feet.

The vessel is designed for a maximum boom lift of 300 tons over the side. Because of the watertight subdivisions into which the barge is divided, it is intended eventually to devise a ballasting system which will give a lifting capacity of 600 tons.

The *Monarch* is built on the Ellis channel system of hull construction, the hull being divided into 19 watertight compartments by 3 transverse and 3 longitudinal bulkheads.

Provision is made in a large steel deck house to accommodate the hoisting engines and boilers, pumps, generator, crew's quarters and galley, the latter occupying the after end of the vessel. Special attention has been paid to the lighting and ventilating systems in the crew's quarters and engine room. The shell, deck and framing are formed of 18-inch channels while the transverse and fore-and-aft bulkheads are built up of 12-inch channels. In the case of these bulkheads, the channels were laid horizontally in order to resist to the best advantage the bending and twisting stresses set up in the vessel's structure when the boom is lifting its maximum load. Specially designed foundations have been provided in the *A* frame legs and boom heel in order to distribute the severe stresses occasioned when lifting heavy loads over the greatest possible area of the structure.



Derrick barge Monarch

The framing, which is of 18-inch structural steel channels, is continuous across the bottom and back and up the sides and is slotted out in way of flanges of the shell and deck channels and is riveted to the webs of each shell channel. The flanges of the shell and deck channels are secured to each other by 7/8-inch diameter wide spaced rivets.

The derrick barge is fitted with water ballast tanks having a total capacity of about 300 tons. In addition, provision has been made for carrying 150 tons of fresh water for the boiler feed, sanitary and other services: the fuel capacity is 170 tons of coal.

Hatch Coverings

UNDER the provisions of section 4405, Revised Statutes of the United States, as amended by the act of Congress approved February 8, 1907, the executive committee of the Board of Supervising Inspectors, Steamboat Inspection Service, at a meeting held in Buffalo, N. Y., on October 1, 1927, adopted the following resolution:

Resolved, That section 16, Rule XI, page 122, General Rules and Regulations, Great Lakes, edition of March 23, 1927, be struck out and the following substituted therefor:

It shall be the duty of the master of any vessel under the jurisdiction of the Steamboat Inspection Service, and which is carrying cargo, to assure himself before leaving port that all the cargo hatches of his vessel are properly covered and the covers secured. The covers of all exposed cargo hatches shall be made watertight by fitting to pliable gaskets, or by being thoroughly covered with hatch cloths or tarpaulins firmly secured by iron or steel bars extending from side to side or end to end of hatchway, which bars shall be fastened by toggles or wedges of hardwood or by efficient screw fastenings. Wooden hatch bars of sufficient size or strength maintained in good condition may be accepted in lieu of the iron or steel bars above referred to: *Provided,* That vessels having 6 feet or more of freeboard, measured vertically from the water's edge at the lowest point of sheer to the top of deck at the ship's side, shall not be required to use the hatch cloths or tarpaulins between March 31 and August 31. This exemption, however, does not relieve the master of any responsibility for the security and protection of his hatches during the interval of exemption, and in case of indications of bad weather or other threatening conditions, he shall not leave port until the cargo and other exposed hatches are properly covered, secured, and protected: *Provided further,* That vessels engaged in the sand or gravel trade, fitted with sand boxes or hoppers, the capacity of which does not exceed the safe carrying capacity of the vessel, need not be provided with covers, hatch cloths, or tarpaulins and fastenings for the sand boxes or hoppers. Failure of the master of any vessel to observe this regulation shall be sufficient cause for suspension of his license on a charge of inattention to his duty. (Sec. 4405, R. S.)

The above action of the executive committee was approved by the Secretary of Commerce on October 10, 1927, under the provisions of section 4405, Revised Statutes.

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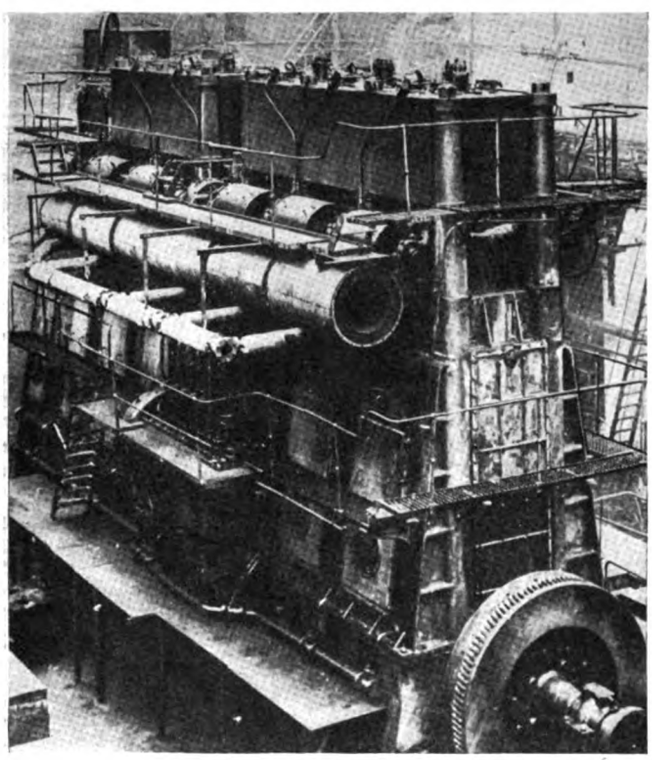
Holt Cargo Liner Eurybates

15-knot ship with new type of Still combined steam and oil engine

By Our London Correspondent

SINCE they first took to motor propulsion in 1923, Alfred Holt and Company, which, as the Blue Funnel Line, operate the Ocean Steamship Company and the China Mutual Steam Navigation Company, have shown little interest in steam machinery, and they now have ten large motorships including two of the fastest cargo vessels in the world, the 15-knot *Idomeneus* and *Orestes*. These owners have long had a reputation for interesting themselves in what is novel, a recent example being their adoption of what is termed high elastic limit steel, enabling an increased deadweight of about 3 percent to be carried in cargo vessels. They



2,500 brake horsepower Scott-Still engine

were also the first and only shipping concern to take up the very interesting Still type of combined steam and oil engine, which seemed to offer such promise, but which apparently, most shipowners consider, gave such a high theoretical efficiency at the expense of somewhat complicated mechanism.

In 1924, the *Dolius* was built for the Blue Funnel Line, equipped with Still machinery constructed by Scotts' Shipbuilding and Engineering Company. This vessel has been in regular service to the Far East, and has, apparently, given satisfactory results, while her fuel consumption is certainly the lowest of any vessel afloat, averaging about 0.37 pound per brake horsepower hour for all purposes. About a couple of years later, Holts placed an order for a second vessel to be equipped with similar machinery, but the construction was delayed a long period for certain reasons and the new ship, the *Eurybates*, was only completed towards the latter part of March.

Many new features have been introduced in the machinery as compared with the original Scott-Still engines, and in every possible way use has been made of all available heat, so that it is anticipated the machinery of the *Eurybates* will represent the last word in economy so far as modern motorship construction is concerned. It will have to be agreed, however, that this has been achieved to some extent at the expense of simplicity, and the question will arise whether it pays to attain the last decimal point of economy at all costs, or whether it is preferable to simplify the installation to the maximum degree even if efficiency thereby be slightly reduced. No doubt the ultimate decision depends also upon the question of capital cost, and it would seem that machinery of the Still class must be more expensive than the normal Diesel type.

The *Eurybates* is 425 feet in length, has a beam of 54 feet 6 inches, a depth of 32 feet 9 inches and carries about 8,000 tons of cargo. The machinery output in normal circumstances will be 5,000 brake horsepower, and when fully laden the *Eurybates* should attain a speed of approximately 15 knots, although it is reckoned that her average service speed will be 14½ knots. It is hoped to attain this with a total fuel consumption not exceeding 18 or 19 tons daily for all purposes.

Unique Engine Room Installation

Even apart from the novelty of the new propelling engines, the general machinery installation is unique. Not only are the exhaust gases from the main engines passed through a boiler, of which more will be said later, but those of the four cycle Diesel motors driving the three large generators are also led to the boiler so that the heat may be extracted from them. There is, moreover, a fourth auxiliary engine coupled to a dynamo, this being an entirely novel two stroke, single acting design of Scotts. The jacket water from it, however, is maintained at a high temperature and forms part of the closed jacket water circuit of the main propelling engines. In this way, to some extent, it operates on the Still principle, but it will be gathered that with this attempt to gain the last calorie from the exhaust gases and cooling water, the piping is on a somewhat extensive scale.

The New Still Engine

The Still principle consists essentially of the adoption of a Diesel engine, but with lower than normal compression, (375 pounds per square inch) and an arrangement whereby the circulating water is maintained at a high temperature and kept in circuit with a boiler in which steam is raised, corresponding in pressure to the temperature of the jacket water.

In the engines of the *Dolius*, this steam was raised at a pressure of about 140 pounds, and supplied to the internal combustion cylinders below the pistons. A complete change has been effected in the *Eurybates'*

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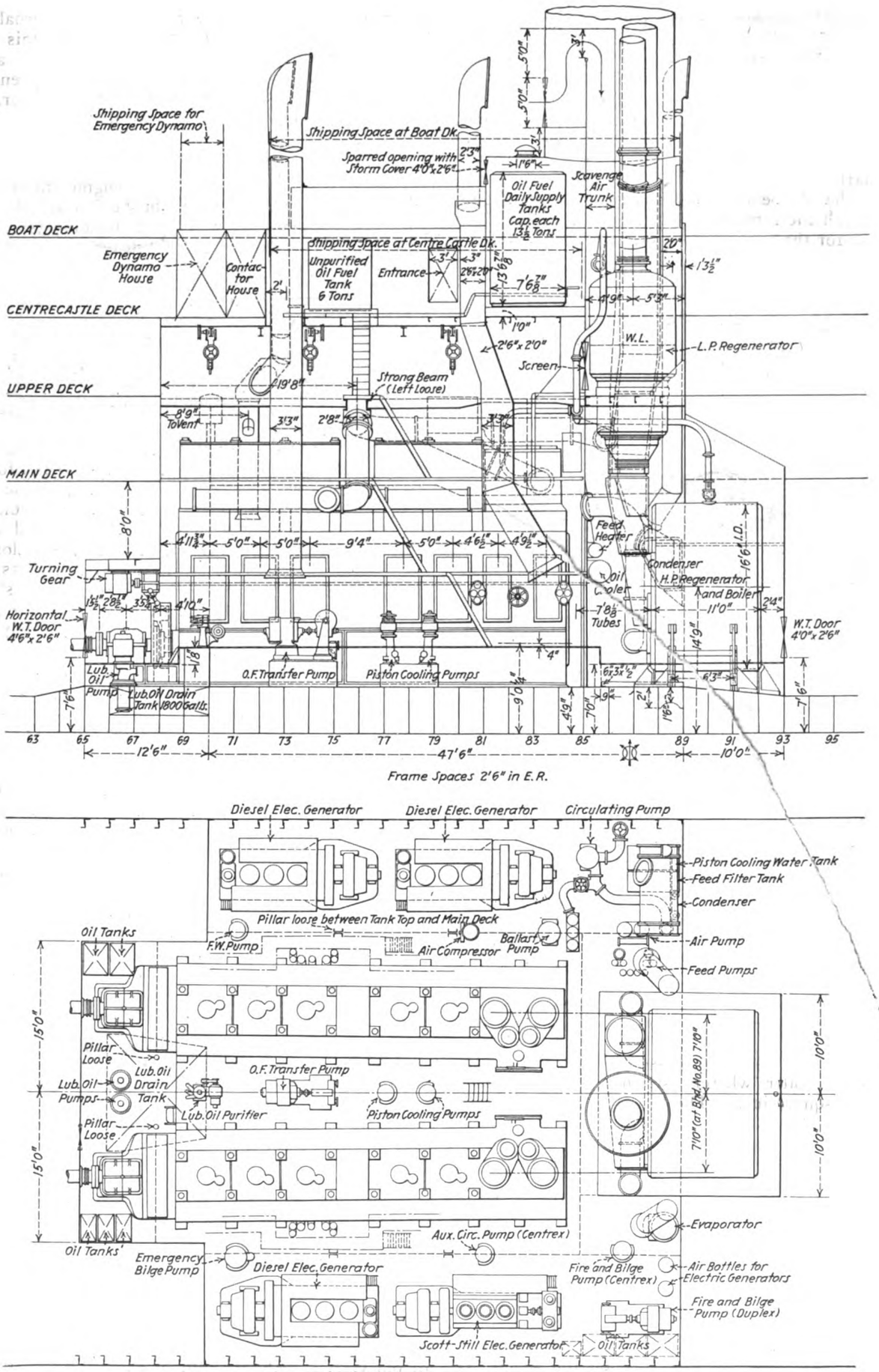

Longitudinal section and plan of engine room

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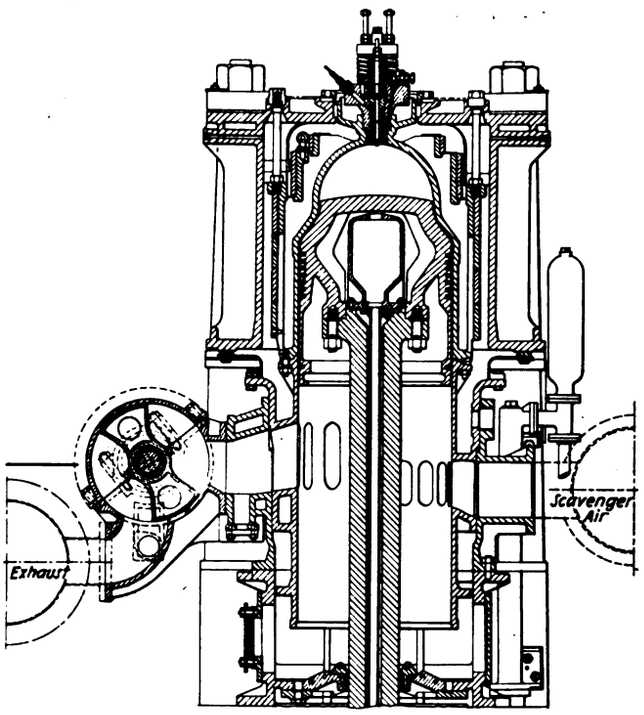
engines, which, incidentally, are much larger, each developing 2,500 brake horsepower. They are 5-cylinder units and operate solely as internal combustion motors. The steam from the boilers is supplied to two entirely separate cylinders forming part of the main engines, these cylinders acting only as steam engines. Thus, there are 5 internal combustion cylinders and 2 steam cylinders to form a complete engine, all with a common crank shaft.

It need hardly be remarked that several advantages arise through the separation of the two sections. The valve gear for the steam at the bottom of the cylinders



Cross section through oil engine cylinder showing rotary valve in exhaust passage

in the *Dolius'* engines was somewhat complicated and the question of the most effective lubrication is not easily solved.

The Steam Plant

As previously mentioned, the cylinder jackets are in circuit with a boiler or a regenerator as it is termed, in accordance with the normal Still principle. The steam raised in this boiler, however, is at a pressure of only 15 pounds per square inch. The exhaust gases from the engines are also passed around this boiler and another boiler wherein steam is raised at 180 pounds per square inch. The latter boiler, but not the former, is capable of being oil-fired, so that when starting and maneuvering, or when additional steam might be required for increasing the speed of the ship, oil burners can be brought into operation.

In the normal way, when the vessel is under way, the steam raised in the 180-pound boiler is reduced to a pressure of 15 pounds per square inch, mixed with the steam raised in the regenerator at the same pressure and the whole supplied to the steam cylinders. This probably adds between 10 and 15 percent to the power obtained, and represents the main advantage of the Still system over the ordinary Diesel principle.

After the steam has passed through the steam cylinders, it is exhausted into a small high speed turbine, coupled to the turbo blower, which supplies the air necessary for scavenging purposes in the internal combustion cylinders of the main engines. As this steam is not sufficient to drive the scavenging blower at full load, additional steam is supplied from the regenerator and, if necessary, from the high pressure boiler. Ultimately, the steam passes into a condenser.

The Diesel Engine

From the Diesel side, the new engine differs from the Scott-Still motors installed in the *Dolius*. A square form of cylinder head is utilized, forming two strong entablatures as indicated in the illustrations. The tension stresses are taken through long through-bolts and the tops of the cylinders give an appearance of extreme simplicity, as there is only a fuel valve, which is automatic. Airless injection of fuel is utilized, and the fuel pumps are timed so as to inject the oil at the exact moment required, according to the position of the piston. Thus, although the engine is complicated on the steam side, it is simple so far as the Diesel portion is concerned.

With the ordinary system of scavenging in two stroke Diesel engines, the exhaust ports are open for the short period after the piston has covered the scavenging port on its upward stroke. In order to avoid this, in the new motor, rotary valves are provided in the exhaust trunk so that the exhaust ports are closed at about the same time as are the scavenging ports.

Compressed air is, of course, not needed for starting since the engine is maneuvered wholly on the steam cylinders. In order to effect this, as previously mentioned, the oil burners under the high pressure boiler are lighted, and sufficient steam is available to give the engine any number of maneuvers that may be needed. Actually, the internal combustion engine cylinders come into operation after very few revolutions.

It was not possible to make complete trials of the machinery on the test bed, but it is estimated that the overall consumption of fuel for all purposes in the ship will be about 0.36 pound per brake horsepower hour. If this is the case and the machinery operates without any trouble and it can be shown that its cost is not much more than the normal Diesel plant, it is still possible that there will be a future for this class of machinery. Hence the performance of the *Eurybates* is likely to be watched with close attention.

Application of Electricity On Board Ship Increasing

By W. B. Basset*

ALTHOUGH the number and total tonnage of new vessels ordered during the twelve months ending March 31, 1928, have fallen well below the figures of the preceding year, the application of electricity on board ship has materially increased. An analysis of marine engineering developments during this period clearly indicates that the economies realized through the use of electrified equipment are being recognized by the owners and operators of vessels of all classes.

This statement is supported by the contracts awarded during the last twelve months for the modernization of old vessels. Almost without exception the auxiliary

* Propulsion section head, Westinghouse Electric and Manufacturing Company.

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machinery of these ships has been partly or wholly electrified, even in steam propelled vessels, while three large freighters will have their steam propulsion machinery replaced by electric drive.

This increasing preference of the marine industry for electrical apparatus can be best illustrated by the following review of Westinghouse installations awarded during the company's past fiscal year which ended March 31. This review includes new vessels and those reconditioned or converted, grouped according to the type of installation.

Diesel Electric

One of the most important types of Diesel electric installations is the equipment of the three large Shipping Board freighters *Triumph, Defiance and Courageous*. The original 3,000 shaft horsepower steam propulsion machinery and steam-driven auxiliaries of these vessels will be replaced by Diesel electric propelling equipment of 4,000 shaft horsepower and completely electrified auxiliaries.

This type of propulsion was selected after careful analysis of conditions to be met and results accomplished which involved an increase in speed from 10½ to more than 13 knots and the utilization of a high efficiency low speed propeller. The complete electrical equipment of the *Triumph* and *Defiance* will be supplied by Westinghouse.

Of almost equal importance is the Diesel electric installation of 3,200 shaft horsepower with electric auxiliaries for a large tanker to be built for the Standard Oil Company of California. This will be the highest powered Diesel electric tanker in the world. The economy of operation of the port load justifies this installation in which power for the cargo pumps is taken from one of the main generators, thereby eliminating the usual auxiliary power set. Reliability in service also strongly influenced the owners in selecting this type of installation.

Other Westinghouse installations of this type of propulsion include a ferry for the Florida Ferry Company; the auxiliary schooner yacht *Guinevere;* a river towboat for the Standard Unit Navigation Company of St. Louis; two U. S. Navy submarines, *V-5* and *V-6*, and a 950 shaft horsepower ferry for the Golden Gate Ferry Company of San Francisco.

In connection with the last mentioned ferry, it is interesting to note that this is the seventh Diesel electric ferry that has been built for the Golden Gate Company and the fourth to be equipped by Westinghouse in a year's time. The reliability and ease of control of Diesel electric drive together with the immense saving of time lost through overhaul and repair, are strong factors in the rapidly growing popularity of this type of propulsion for ferries.

The Westinghouse Company, which has pioneered in Diesel electric proppulsion, has received 9 of a total of 14 contracts for installations of this type awarded throughout the world during the past twelve months.

Turbine Electric

Two turbine electric installations involving engineering innovations were contracted for during the past year. These are for two large cutters for the U. S. Coast Guard and are of 3,000 shaft horsepower each. The propulsion motors for these cutters are of the synchronous type, while the installations are designed in accordance with the central power station idea, whereby auxiliary power under ordinary cruising conditions is taken directly from the main turbine generator. This arrangement eliminates to a large extent the ordinarily uneconomical operation of auxiliary power sets. The speed of the cutters will be 16 knots with a propeller speed of 163.5 revolutions per minute. Westinghouse, which was awarded contracts for the equipment of three similar cutters last February, will also equip these two vessels.

Geared Turbine

An interesting geared turbine propulsion installation was awarded to Westinghouse by the Inter-Island Steam Navigation Company. This represents the complete propelling and auxiliary equipment of a new twin screw vessel of 4,000 shaft horsepower, which will be equipped wih high efficiency turbines of the impulse reaction type. The turbine speed of 3,600 revolutions per minute will be reduced through single pinion double reduction gears of the floating frame type to a propeller speed of 135 revolutions per minute. The turbines will have a working steam pressure of 265 pounds at the throttle, with 75 degrees of superheat, while Westinghouse air ejectors of a new design will help to maintain a vacuum of 28.6 inches. A large part of this vessel's auxiliary machinery will be electrified, power for which will be supplied by two geared turbine generator sets of 100 kilowatts each.

Electrical Auxiliaries

In addition to the electrical auxiliary machinery included in the foregoing installations, Westinghouse during the past year has supplied many other vessels of various classes with electric auxiliary equipment. These vessels include several that were reconditioned and others that have direct Diesel propulsion installations. This class of equipment is comprised principally of motors and control, switchboards and generators, although a fair amount of orders were received for complete auxiliary turbine generator sets.

Among the outstanding auxiliary installations are the Sun Oil Company's new tanker *Sunoil*, and the New York and Cuba Mail Steamship Company's reconditioned passenger vessel *Havana*. Another auxiliary contract of importance is the new direct Diesel driven yacht *Savarona*, owned by Mr. R. M. Cadwalader, Jr., of Philadelphia. Thirty-three Westinghouse motors drive the auxiliaries of this large pleasure craft which, except for the propulsion equipment, is completely electrified. These auxiliaries include engine room pumps and compressors, winches, anchor windlass, steering gear and complete electrical equipment, including motors and control for operating the gyro stabilizer. Westinghouse is also supplying the electrical auxiliary equipment of the Gulf Refining Company's new tanker, *Gulfspray*.

Electric Dredge

Another marine installation of considerable interest and importance is one of the largest non-propelled Diesel electric suction dredges in the world. The dredge is being built by the Ellicott Machine Corporation of Baltimore, and will be used on the Panama Canal. The electrical equipment which Westinghouse will supply will have a generating capacity of 2,200 kilowatts and, in addition to four main generators, will include a main pump motor of 2,500 horsepower, a cutter motor of 350 horsepower and two motors for hoisting and hauling of 100 horsepower each.

Correction.—In the description of the passenger steamship *Dixie*, in the March issue, it was erroneously stated on page 141 that each boiler is fitted with a circulator. This should read "feed water regulator."

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Corrosion in Machinery and Piping

A summation of the best available information and practice—Methods of combating corrosion

By Captain H. C. Dinger, U. S. N.

THE ravages of corrosive action in the machinery and piping of vessels are very extensive. The cost of replacement of corroded piping, boiler and condenser tubes is one of the largest items in a ship's repair bill. A great deal of this corrosion can be avoided by using proper material, by the employment of proper protectors and by avoiding conditions conducive to corrosion.

What is needed is not so much a knowledge of the exact theory of all the various corrosive actions, but a more intimate knowledge on the part of the operating personnel of the proper action to take to avoid and reduce corrosion, and on the other hand the exercise of greater care by the designers and builders in selecting the most suitable material and providing the most efficient protectors and preservatives. These are the best means for combating the corrosion problem.

Corrosion is natural, it is to be expected, hence it is accepted. By care and attention it can be reduced very materially.

Boiler Corrosion

This has been extensively covered in engineering literature, yet a great deal of corrosion continues to go on in boilers. It is due to salt water, air and possibly acidity.

With tight condensers, careful use of pumps and tight boiler sea connections, the salt content in the boiler water can be kept fairly low. Air can be kept out by (1) insuring a water sealed suction for the feed pump (a goose neck will do this), (2) providing the feed tank with sufficient air liberating surface and with means for permitting this air to escape, (3) providing air chambers on feed heaters and feed piping from which air can be blown, (4) providing feed lines and feed tanks with boxes containing iron turnings to absorb the air.

The air entering boiler with the feed should be permitted to get to the steam space as quickly as possible and without touching the tubes and boiler plates. If feed water is preheated to a high temperature it will contain much less air than when cold. Hence feed heating is exceedingly desirable as a boiler preservative.

Boiler water can be prevented from becoming acid by adding alkali in the form of soda or lime. If the boiler water is constantly maintained slightly alkaline by a continuous drip feed of soda solution, destructive local acid corrosion or that due to electrolytic action will not result. The addition of alkali will also neutralize the effect of a slight addition of salt leakage, which can not be entirely prevented in practice, and it will also neutralize any other acid in the feed due to various impurities, oil and foreign matter.

The remaining source of corrosion will be that due to the air left in the water and that due to corrosive gases liberated by the boiling of the water. If the water is purely distilled, there are no such corrosive elements. However, magnesium chloride in sea water liberates some hydrochloric acid, and if this is not immediately neutralized, it will corrode the metal.

The internal feed pipe is a most important item in avoiding corrosion due to the presence of air. Air is liberated while the water is heated and before evaporation takes place. The feed should, therefore, enter near the water level so that the air bubbles can quickly get to the steam space. The flow of water should be evenly distributed so that liberation of the air is not concentrated in any one place. The thing to be particularly avoided is a flow of air into the tubes in watertube boilers.

Most boiler compounds used in marine boilers are employed to neutralize acid and remove scale. Soda as a rule is the active element. This acts as a protective adjunct insofar as it neutralizes any acid in the boiler water. Navy Standard Boiler Compound containing soda ash, 76 percent; tri-sodium phosphate, 10 percent; tannin, 2 percent; residue starch, has been used with very favorable results in the Navy for many years. For marine boilers it appears more advisable to use soda ash or sal soda rather than other sodium compounds. Kerosene is a good oil and scale remover but must be used with discretion.

Condenser Corrosion

Condenser tubes appear to be particularly subject to corrosive action. Years of service on naval vessels indicate that tubes made to conform to naval specifications (Admiralty metal) give satisfactory service when subjected to proper operation. Material even slightly different from this sometimes gives unsatisfactory service. Zinc protectors in the water chest of condensers, distillers, oil coolers, etc., seem to be useful in arresting deterioration. They must, however, be cleaned frequently or they will not be as effective as they should be.

Obstructions in the tubes which prevent a proper flow of water may cause local overheating and initiate corrosion. Ashes or gravel lodging on the tube surface may also cause local pitting. Over-expanding of tubes and necking by setting up too hard on packing will cause deterioration at the ends. Any abrasion or nick on the interior surface of the tubes or the rolling in of any impurities may be the occasion for local corrosive action. Overheating condenser or running condenser hot may cause corrosive action. Air pockets may also cause corrosion.

It is probable that a good deal of condenser tube corrosion is due to air and that any unusual churning of the water in its path to the condenser tubes may accelerate such action. There is apparently very little that can be done to keep out the air. Action can, however, be lessened by, (1) expanding tubes in the tube sheets instead of using packed tubes with ferrules, (2) using single pass condensers, (3) venting the top of water chests to get rid of accumulation of air, (4) designing water spaces so that an even flow of water is secured and churning avoided.

Electric protective systems are used to a greater extent in power stations having contaminated water, but are also intended for use in marine work. It is claimed

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for them that they actually do what zinc protectors are expected to do.

A great deal of condenser tube corrosion may be attributed to acid contaminated water in harbors where vessels may have to lie for considerable periods. In such cases most of the trouble may be avoided by closing the condenser sea valves and draining the condenser just as soon as the main engines are no longer required.

Different treatments of tubes to prevent corrosion have from time to time been proposed, but these do not appear to have proven very effective. A uniform smooth clean surface of Admiralty metal appears generally to give best results but it is desirable to obtain initially a protective film which may be produced naturally by salt circulating water or artificially by means of solution of sodium silicate, salt, or milk of lime.

Piping and Water Systems

Piping conveying both fresh and salt water on board ship deteriorates rapidly. The greatest action appears to come where hot salt water is present.

Cold salt water can be transmitted through cast iron or steel pipes without much action, but where air is present corrosion will be more active.

Galvanizing or tinning such pipes affords protection till the coating wears off. Copper or composition pipe suffers comparatively little action from cold sea water. Copper pipe can be effectively protected by a solder (one part tin and two lead), and also by tinning.

Brass pipe suffers little deterioration from salt or fresh water, except at joints when hot salt water is used. Composition fittings suffer less deterioration than piping or tubing but are expensive. Brass pipe made of copper 80-85, zinc 15-20, sometimes known as red brass, has been found to last better than copper or other brass pipe.

Lead does not suffer deterioration from either fresh or salt water. It can be used as a lining for steel salt water piping, a practice which has been followed by the Navy for fire main and flushing systems for many years. Recently systems of lead dipping similar to the galvanizing process have been developed.

Monel metal and nickel are practically non-corrosive, but are expensive. Special cupro-nickel compositions are also being developed which are non-corrodible under ordinary conditions. Some of these are only slightly more expensive than brass or composition.

Wrought iron piping can be used for cold fresh water with practically no deterioration, but if used for hot fresh water active pitting results. Special makes of iron, that depend on extreme purity or on the use of chromium, nickel or copper, are successful in lessening corrosion.

Steel or iron galvanized pipe can be used for cold fresh water with little deterioration and for cold salt water with slight deterioration.

Protective Coatings

Coatings can be put on piping to preserve it. The most widely known and the cheapest process is galvanizing. Galvanizing, however, wears off, and when worn off the corrosive action goes on. Tinning is also used. This is more expensive and the tin coat also wears off.

For copper pipes intended for salt water a coating of two parts lead and one tin, if properly and evenly applied, furnishes a very good protection. This coating has been used in the Navy for many years, and is effective. It is, however, next to impossible to have all parts of the piping properly coated.

Interior coatings of tar of bitumastic origin have been tried with indifferent success. The usual trouble is that the coating does not stick when subjected to vibration, changes in temperature and the flow of hot water. When these coatings flake off they lodge in the pipes and valves and cause obstructions. For cold water it would appear that a proper bitumastic coating that might be applied by dipping or spraying and following through with a brush could be developed. A coating of this kind sprayed on the internal surface of tubes has recently been successfully used on marine condensers by the Cunard Company, described in *The Marine Engineer* of March 1925 by Mr. Austin. Coatings of this kind, as well as paints such as red lead, are very successfully used for protection of exterior surfaces of piping.

A baked or sprayed enamel that will not crack will probably be developed eventually since the need for it is so great.

Parkerizing is a process of rust proofing of ferrous articles whereby the surface is protected by phosphates taken from the solution replacing particles of iron that are dissolved. This process is cheaper than galvanizing and is used extensively in industry for protection of delicate parts from atmospheric rust. It also serves as a good basis for paints and enamels, greatly improving the protection from corrosion. It should apparently have considerable application in the marine field where galvanizing or plating can not well be used.

Silicate of soda (water glass) can be applied effectively as a corrosion deterrent in both salt and fresh water piping systems where ferrous material is used.

It can be applied to the system by adding a concentrated solution to the water which will produce a thin protective film on the surface of the metal. The system can then be dosed periodically. This has been applied to domestic water systems with marked effect in arresting corrosion and has a useful application in marine service.

Chromium and cadmium plating of steel has been developed recently. These substances are much more effective than is nickel for rough wear and for protection from corrosion. Chromium gives a very hard surface, practically corrosion proof. Chromium plating might be used to plate rods and shafts where they pass through steam stuffing boxes and where due to the action of rust from the moisture the rods and packing are cut and caused to deteriorate.

Non-Ferrous Metals

Good homogeneous composition castings and bronzes suffer comparatively little from the action of salt water. Rolled or worked material, whether composition, iron or steel, suffers more than cast material.

Many aluminum bronzes are likely to disintegrate from the action of salt water or from alkalis such as boiler compound. Other aluminum compositions appear to be able to stand salt water very well.

Composition castings where zinc is not well distributed are liable to dezincification when subjected to action of strong alkalis such as boiler compounds.

Monel metal and nickel appear to be subject to but very little action due to either salt or fresh water. They are, however, both expensive materials. Special alloy mixtures containing copper and nickel are being placed on the market as non-corrodible metal. Some of these

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are very successful, but they cost more than ordinary composition.

Contact of aluminum with steel or other metals in the presence of sea air is liable to cause local corrosion. Dissimilar contacts should therefore be avoided as much as possible and where unavoidable an insulator of paint or some other suitable material should be applied.

New Non-Ferrous Alloys with Special Non-Corrodible Properties

Three corrosion resistant copper alloys that have been used in the chemical industry and which may have considerable application in the marine field are Everdur, 95 Cu., 4 sil., 1 mg., Ambrac, 75 cu., 20 ni., 5 zinc; and Everbright 60 cu. 35 ni. All of these have higher tensile strength at high temperatures than the ordinary bronze or composition and possess high non-corrodible and anti-erosive properties. They are of course more expensive than ordinary bronze or composition. Much valuable information in connection with non-corrodible alloys may be found in the October, 1926, issue of *Chemical and Metallurgical Engineering.*

The above metals may be used in lieu of monel metal or stainless steels for various special services. They have the advantage of better workability and machineability and if used extensively will probably be cheaper for some of the services.

Influence of Electric Grounds

Electric grounds on vessels are in many cases responsible for rapid deterioration of metal parts of vessels, particularly plating, shaft struts, etc. Occasionally a line of piping, a condenser or other unit may be situated so as to be subjected to the effect of the ground. The damage due to grounds is usually indicated in some extraordinary or exceptional manner. Hence, when some erratic or special evidence of corrosion is discovered, it is well to make a special investigation and remove all electrical grounds and properly insulate the unit.

Non-Corrodible Alloy Steels

Certain large electrical companies, the General Electric Company in particular, have by experiment developed aluminum alloys that will resist the action of sea air, and aluminum alloys are now being used for electrical fittings on board ship extensively.

Stainless steel of the proper composition (usually high chromium-nickel) has been found superior for use as valve trimmings, small control valves, turbine blading and nozzles and generally in places where cutting and erosion takes place when ordinary steel or composition is used. These special alloy steels resist corrosion and also the eroding and cutting action of steam.

Copper bearing steels have been found to resist general corrosion materially better than ordinary steels hence their use in ships structural parts and for boiler plates, tanks, casings, particularly in places where it has been found difficult to properly protect the metal from the corrosive action of moisture.

The use of non-corrodible alloy steel is now being considered for marine condenser tubes and some experimental installations have been made.

The Use of Deaerators

In shore plants deaerators have been installed during the last few years which remove the air from the condensate before this is pumped to the boiler. These devices have been quite successful in shore plants, but as yet have not been introduced into marine practice to any considerable extent, chiefly due to the weight, expense and extra space required. It is however not at all unlikely that such deaerating devices, if installed in conjunction with stage heaters and economizers on boilers, would fully justify themselves.

The presence of air mixed with steam which is rendered corrosive at the saturation point, is now considered responsible for a great deal of the corrosion found in turbine blading on high pressure stages.

Kerosene as a Cleanser

If steel or iron is thoroughly cleaned with kerosene, it rusts very rapidly due to the fact that the surface of the metal does not contain any protecting film of oil. This fact has often caused kerosene to be considered as corrosive; the kerosene cleans the metal so thoroughly that moisture and atmospheric oxygen come in intimate contact with the metal and cause it to oxidize rapidly. After a surface has been cleaned with kerosene, or any other cleanser, in order to preserve the surface, it should be covered with some light oil to form a protective film which will prevent rusting. Injudicious cleaning whereby protective oil films are removed and not replaced may therefore hasten corrosive action.

Corrosion of Gasoline Engines

Gasoline when used as a fuel for internal explosion engines gives water as one of the products of combustion. If there is considerable leakage of the burned gases into the crank case of the engine, the steam in the exhaust vapors condenses to water and mixes with lubricating oil in the crank pit. Should the gasoline used contain in excess of 0.10 percent of sulphur, there is apt to be severe corrosion of the engine due to the formation of sulphuric acid in the condensed water vapor.

General Conclusions

Combating corrosion in marine work is a far more serious problem than in shore practice. The several and combined effects of natural moisture, salt water and salt water spray are exerted inside and outside of the machinery as well as the ship's structure and only constant vigilance in detecting the onslaught of corrosion in its first stages, coupled with the most intelligent practical preventive and corrective measures to control the corrosion, can lessen the large toll paid annually to this destructive agent.

Careful and frequent inspection should easily detect the first signs of corrosion. A systematic study of the conditions existing with a view of determining the best remedy should then be made. Once the corrective measures are instigated, careful observation should indicate whether or not the proper solution of the problem has been obtained.

In many cases the proper preventive measures can be found only by trial and error. Inasmuch as corrosion is generally a slow but certain process, the efficacy of the preventive methods used in any cases can be determined generally only after long periods of observation. The old doctor's adage, "an ounce of prevention is worth a pound of cure," is distinctly applicable to "corrosion," the white plague of the metal world.

MOTOR LINER KUNGSHOLM LAUNCHED.—The motor liner *Kungsholm,* building for the Swedish American Line for service between New York and Gothenburg, Sweden, was launched March 17 at the shipyards of Blohm & Voss in Hamburg. With engines of 24,000 horsepower she will have a speed of 18 knots.

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Diesel Engines for the Navy*

Existing naval oil engine installations — Calculating the propelling plant requirements — Auxiliary plant

By Edward C. Magdeburger

THE development of the Diesel engine from a mere idea in 1893 to units of 15,000 brake horsepower for the Hamburg Electric Power Company and ships carrying a total of 28,000 brake horsepower with millions of horsepower in a variety of every day uses, including trucks and locomotives, is a truly inspiring picture of our day.

Some of the more important characteristics of the oil engine responsible for its success are as follows:

(*a*) It may be started instantly and brought to carry its full rated load within a few minutes.

(*b*) It is economical in fuel consumption, being 2 to 3 times and more as economical as the steam engine or steam turbine installation.

(*c*) It maintains its efficiency.

(*d*) It has an invisible exhaust.

(*e*) It requires less operating personnel.

(*f*) It is not dependent for its operation upon the extensive high pressure steam piping.

If the industrial world has appreciated these advantages of the oil engine, it becomes of interest to investigate to what extent the oil engine has been used in the various navies of the world and how it could be applied to satisfy best the essential requirements of a naval power plant.

The power plant of a naval vessel is divided into two separate sections (*a*) main propelling and (*b*) auxiliary power; and under these headings the subject of this paper will be discussed.

Existing Oil Engine Installations

When speaking of oil engines in the Navy all naturally think of submarines which owe their development out of mere scientific toys and small harbor watchdogs into the U-boat of the world war, to the perfection of the oil engine. The latest official data credit the United States with the possession of a fleet composed of 125 vessels powered by Diesel machinery totaling 155,040 shaft horsepower.

The oil engines in this formidable fleet of submarines vary from 120 brake horsepower each to a total of about 7,000 brake horsepower in the more modern fleet submarines and make Uncle Sam one of the largest users of oil engines in the world. These engines are all of what is commonly known as high speed type (325 to 425 revolutions per minute) and embrace both 2-cycle and 4-cycle types with the latter predominating both in number and total output, although the largest individual engines are of about equal power.

The faith of other great nations in the oil engine as the propelling plant for submarines is evidenced by the fact that the British navy includes 61 submarines propelled by this means totalling 92,400 shaft horsepower. The Japanese navy lists 68 submarines with Diesel machinery developing 190,400 shaft horsepower.

Up to November, 1918, the German fleet included 355 submarines of the U class, U B class and U C class, with a total of 419,280 shaft horsepower. At the close of the war more than 100 additional high powered submarines were under construction.

The only other ships in the United States Navy having oil engines for their propelling plant are the submarine-tender *Fulton*, equipped with a 6-cylinder, 2-cycle Nelseco-M. A. N. of 1,100 brake horsepower, and the oiler *Maumee*. The propelling plant of the *Maumee* consists of two 6-cylinder, 2-cycle M. A. N. valve scavenging type engines of 2,500 brake horsepower, built at the Navy Yard, New York, which at the time of their installation were probably the most powerful engines afloat.

Installations on Auxiliary Ships

Other navies are more fortunate and boast more modern auxiliary vessels equipped with oil engine propelling plants. Netherlands has a submarine depot ship *Pelikaan*, equipped with two M. A. N. 2-cycle valve scavenging engines developing 700 brake horsepower at 250 revolutions per minute, driving the propellers by means of electric drive. Three armored gunboats used in the East Indies develop their 14-knot speed by means of a most unique engine of a Werkspoor 4-cycle type rated 1,200 brake horsepower at 300 revolutions per minute. This twin engine operates on two shafts with center lines of cylinders inclined, building one inverted V and their jackets rigidly connected.

Great Britain is credited with only one oiler, *Trefoil*, equipped with two sets of 6-cylinder Sulzer, 2-cycle, 1,500 brake horsepower engines. A pair of modern Vickers M. A. N. double acting, 2-cycle engines, similar to those built by New London Ship and Engine Company and Hooven, Owens, Rentschler Company for the Shipping Board re-engining program, will be installed in a submarine depot ship.

France has recently built her first oil engined auxiliary, a naval tanker, *Le Loing*, equipped with two Burmeister and Wain 4-cycle engines of 2,000 brake horsepower each.

Auxiliary ships, such as transports, oilers, repair and depot ships, do not vary much from the ordinary merchant ships used for that purpose in the United States Navy.

There are at present no capital ships in any navy of the world that employ oil engines for propulsion except probably the British cruiser-minelayer *Adventure* completed in 1926, which has, in addition to its 40,000 shaft horsepower steam turbine plant giving it a speed of 27.75 knots, a Diesel plant for cruising at moderate speed.

The building of an 11,000-ton battleship equipped with Diesel engines is under consideration in Germany and the recently constructed cruiser *Königsberg* is reported to have Diesel engines for cruising, in addition to its 65,000 shaft horsepower steam turbine installation.

* Abstract of a paper read at the thirty-fifth general meeting of the Society of Naval Architects and Marine Engineers, New York, November 10, 1927.

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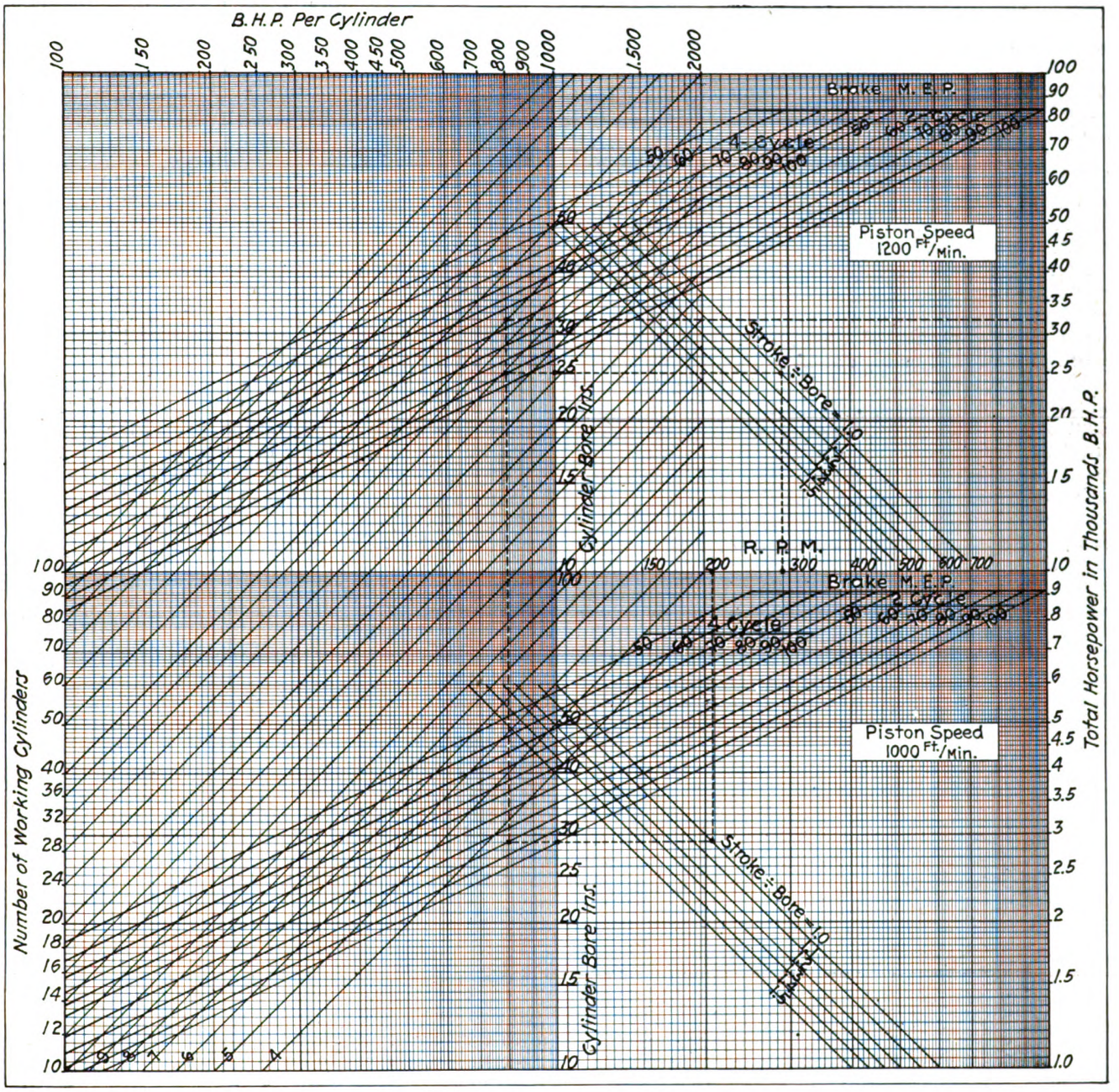

Fig. 1.—Chart for determining characteristics of Diesel engines

Requirements of Propelling Plant for Naval Vessels

Before proceeding with the discussion of peculiarities of propelling plants used on board naval vessels it is believed better to introduce here a quick means for determining the principal dimensions of an oil engine.

In speculating about the dimensions of engines to satisfy any required total shaft horsepower, it is believed to be more convenient to modify the familiar plan formula by introducing mean piston speed—

$$S = \frac{2LN}{12} = \frac{LN}{6} \text{ feet per minute} \qquad (1)$$

where L = stroke in inches; N = revolutions per minute. So that

$$\text{Brake horsepower} = \frac{P}{y} \times \frac{A \times S}{33{,}000} \times n. \qquad (2)$$

where P = brake mean effective pressure (M.E.P.) in pounds per square inch.

y = a constant; $y = 4$ for 4-cycle type, $y = 2$ for 2-cycle type.

A = area of the working cylinder in square inches.

n = number of cylinders.

D = cylinder bore in inches.

In determining the dimensions of the engine the first thing to be settled is usually the piston speed, since that may be assumed independent of the type of engine, whether 4-cycle or 2-cycle, single or double acting. Modern single-acting submarine engines both 4-cycle and 2-cycle, have long been rated at about 1,200 feet per minute and even above, and the huge, double-acting Burmeister and Wain engines have also exceeded this piston speed. A large majority of commercial oil engines are rated at about 1,000 feet per minute. These two speeds have been taken as constants in the chart (Fig. 1), and all the other variables may be expressed by suitable straight lines in logarithmic coordinates. Brake mean effective pressure depends on the type of engine, and here the manufacturer's opinion of his own engine, as expressed by the rating of similar engines

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previously installed, can be obtained from tables similar to those compiled by the author and kept up to date by additions of suitable new data on typical modern installations. Whether air injection be used or not, whether air compressor and scavenging pump be direct connected or not, must be settled before a suitable figure for brake mean effective pressure is arrived at.

Piston speed and brake mean effective pressure will determine the cylinder bore if the number of cylinders may be decided upon. To obtain the shaft speed or revolutions per minute it will be necessary to decide upon the stroke ÷ bore ratio. Engine height and weight are much influenced by this selection. The high speed submarine engines have the smallest stroke to bore ratio, usually 1.0, and are most compact and of light weight, the heavy oil engines of the merchant ships have a stroke to bore ratio as high as 2.0.

Thus the chart may be used, for example, to determine the principal oil engine dimensions for a power plant of 32,000 brake horsepower. For a piston speed of 1,200 feet per minute, and if made of 40 working cylinders of 2-cycle type rated at 90 pounds per square inch brake mean effective pressure, the cylinder bore must be 25 inches, and if a stroke to bore ratio = 1.0 be used, the engine speed must be 290 revolutions per minute.

For the same number of cylinders (40) but for a piston speed of 1,000 feet per minute, a 2-cycle engine of 80 pounds per square inch rating must have a 29-inch cylinder bore and with a stroke to bore ratio of 1.0 must be run at 210 revolutions per minute.

Cylinder bore may also be made the starting point and the number of cylinders for any given shaft horsepower and rating be obtained.

Direct Coupled Oil Engines

It will be noted from the above that only two classes of vessels have so far actually utilized oil engines for main propulsion, namely submarines and auxiliary ships. The reason for this lies in the fact that with very few exceptions, such as the British X-1 and the V class of United States submarines, both of these classes of ships are of comparatively slow speed type and thereby do not possess one of the most important characteristics of a naval vessel, namely, the required operation at widely varying ranges of speed. A naval vessel, no matter what its maximum speed may be, has to be able to cruise for long periods in company with other vessels at so low a speed as 8 knots. This for the cruisers of the *Omaha* class constitutes less than 25 percent of its maximum speed of 34 knots.

The propelling plant of a warship has to make its full rated power only about twice a year with probably four additional availability endurance runs at about 80 to 85 percent of its rating. Thus the engines are required to operate at very slow or economical speeds a large percentage of the time during normal peace times.

Both excessive wear due to continuous running and fuel consumption at partial loads militate against the use of direct coupled oil engines for driving high speed naval vessels of any considerable size. And even in the larger submarines, such as the British X-1 and the V class of the United States Navy, an indirect drive by means of electric motors to obtain more economical fuel consumption and more reasonable wear of the propelling engines has been employed.

It is believed that the time is past when the inclusion of gears between the oil engine and the load is to be considered a hazardous undertaking. In fact, some of the first installations of oil engines in motorships were gear driven, due to the necessity of reducing the engine speed to the required slow speed of the paddle wheel shaft in side wheel tugs.

The first ocean-going motorships fitted with gear drives, *James Timpson* and *Libby Maine,* were built in this country, were equipped with gears by the Falk Company, and have been in successful service since 1917 and 1918, respectively. A number of other gear oil engine drives have been built by this company since. Late reports show that two new passenger liners with geared oil engines of the most modern type—double-acting, 2-cycle, with solid injection and separate blowers totaling 12,100 shaft horsepower—have been ordered by the Hamburg-American Lines for their Atlantic service, which speaks more than mere words for the reliability of the gear drive and the overall desirability of such a method of propulsion.

G. Bauer of the Vulcan shipyard has developed means for separating the disturbing periodic forces of the oil engine from the gear drive and the propeller shaft by using a hydraulic coupling or clutch between the engine and the gear. Thus each shaft system will be subject to its own disturbing influences and have its own critical speeds which are much easier to evaluate and place outside the operating range of the installation.

Electric drive has found considerable favor in the United States Navy, and all the capital ships built since 1915 have been equipped with this form of propulsion. One of the principal advantages of this form of drive is the resulting superior cruising speed economy which is due mainly to using only one out of two or even four generators with correspondingly higher load and better efficiency and secondly to using two different reduction ratios with corresponding increase in the generator speed.

Electric drive has been used extensively in commercial installations of oil engines for propelling ships of various kinds. Direct current generators and motors have been employed in commercial Diesel electric driven ships almost exclusively, chiefly due to ease of maneuvering by varying the field excitation of the generator and the simplicity of reversal.

Direct current is also used in the electric drives of the larger type of submarines, where the motor required for submerged operation with the battery is utilized also on the surface. Here the use of electric drive when cruising at low speed, if the power required does not exceed the capacity of one engine, results in substantial fuel economy, increases the reliability of the installation, and prolongs the life of the oil engines.

Proposed Oil Engine Drives for Warships

Favored by the necessity of creating a new and thoroughly modern navy after the disastrous losses in the Russo-Japanese war, a project of an oil engine power plant for a battleship of 16,600 tons was developed by Lieut. D. Philippow and submitted to the Russian Naval Commission in May, 1905. The world war ended the work on this project.

This Russian proposal, however, influenced Emil Capitaine, a designer of gas and oil engines in Germany in 1906, to propose the installation of a direct drive engine operating on both gas and oil in one of the German ships. The proposal died with the building of a small model of the engine.

In 1925, Captain A. M. Proctor, U. S. N., proposed to re-engine the battleship *Oklahoma* by means of four double-acting 2-cycle engines of 6 cylinders each, direct coupled to four shafts, the normal full power of the engines to be 22,500 brake horsepower at 175 revo-

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lutions per minute, which he proposed to increase to 34,360 brake horsepower at 218 revolutions per minute by increasing the piston speed from 960 feet per minute to 1,200 and brake mean effective pressure from 74 pounds per square inch to 90.

A comparison with the general arrangement of machinery recently installed in the motorship *Augustus* which has a main propelling plant of 28,000 brake horsepower at 125 revolutions per minute, on four shafts and with the same type of engines as those considered by Captain Proctor—namely, double-acting 2-cycle—shows that the author of the proposal was probably unduly enthusiastic in estimating the space required by an oil engine power plant of such size even if it be granted that naval machinery is generally somewhat more economical in space and weight requirements than that of the merchant service, which has to deliver its full rating for weeks and months at a time.

Thus his deductions as to cruising radius were also excessive. However, this proposal provoked considerable discussion, in which a number of high ranking officers of the Navy participated and many other advantages were brought out, such as, for instance, that an oil engine equipped ship is well protected against poison gas attack. The engine room can be easily isolated from outside atmosphere, oil engines taking their combustion air direct from outside, and therefore the ship will keep on developing whatever speed is desired, whereas, to equal that, the boiler room crew would have to work with gas masks on. Lack of smokepipes and smoke is important for airplane carriers. Commander S. M. Robinson pointed out his belief that oil engines on a future naval vessel will be of the high speed type with one of the various forms of reduction gears. Unfortunately some of the discussers singled out Captain Proctor's remarks as to the ultimate possibility of an oil engine propelling plant of 220,000 brake horsepower suitable for such ships as the present airplane carriers *Lexington* and *Saratoga*.

The purpose of this paper is not to present figures, purporting to prove some point, but rather to analyze the situation logically and make general deductions as to the type of plant that would best be suited for the needs of a naval vessel and suggest the now available means for accomplishing that purpose. In the absence of any given problem, this is believed to be the only course to get results, since weight and space figures are dependent upon the size of the plant desired and the particular purpose of the vessel. It is not necessary to call the destroyer power plant unreliable, yet its weight per shaft horsepower is only a fraction of that installed in a battleship, which in turn is much lighter than that used in commercial installations.

Auxiliary Plant

There are at present only two United States battleships, the *Maryland* and *West Virginia*, that have a pair of Busch-Sulzer 6-cylinder, 2-cycle engines of the submarine type driving 400 kilowatt generators for use primarily in port, when no steam need be carried by the ship. To date they have hardly received sufficient appreciation by the engineer officers in charge and, being a new departure for the big ships, they are not operated to the extent they should be to save fuel and operating personnel.

The available data show that a large number of German naval ships were equipped with oil engine driven generator sets during the war, and elaborate test data and constructional details have been published. The units varied from one 40 or 60-kilowatt unit installed in small cruisers to two 300-kilowatt units installed in battleships and armored cruisers.

No details as to auxiliary oil engine generator sets existing in other foreign navies are available, except that for instance the Brazilian battleships *Moreno* and *Rivadavia*, built in United States shipyards, had each two Sulzer engine driven generators of 100 kilowatts.

Naval Requirements for Auxiliary Plant

The auxiliary plant of the United States naval ships varies, two 25-kilowatt generating sets are used on destroyers, two 50-kilowatt units and two 100-kilowatt units on the cruisers of the *Omaha* class, four to six 300-kilowatt sets are used on battleships and six 500-kilowatt sets are installed on the airplane carriers *Lexington* and *Saratoga*. In addition to generating electrical energy, a considerable amount of heat is used in the form of steam for the requirements of the crew, such as in: (*a*) air heaters for heating the living quarters; (*b*) water heaters for washing, bathing, cooking, etc.; (*c*) steam tables and galley; (*d*) laundry.

The conclusions that may be drawn from this cursory review of the situation with regard to the auxiliary plant are:

1. That suitable oil engine driven generator sets can be built, since a large number of them have been installed in German naval vessels of different types.
2. That electricity can be generated by oil engine driven sets at less than half of the fuel consumed by steam turbine sets, even allowing for poor load factor at some parts of the day.
3. Considerable, if not all, of the water may be distilled and low pressure steam furnished for steam circuits by installing exhaust heated boilers and thus saving fuel expenditures for that purpose.
4. That the fuel expenditures for auxiliary purposes are of such magnitude that a saving of about one half of them is in itself a considerable item.
5. Instant readiness, cooler engine room, and smokeless combustion are other equally valuable features of an oil engine driven generator set.
6. The installation of oil engine driven generator sets must be considered independently of the main propelling plant, as it offers important advantages even if the latter remains steam driven. Passenger liners, such as the *Leviathan* and *Malolo*, received auxiliary oil engine sets, and several modern steam-propelled ships built in Germany and England employed oil engines exclusively to generate electricity and furnish hot water from their exhaust.

New Gas-Freeing Method

A NEW method of gas-freeing tankers in which steaming of the tanks is entirely eliminated has been devised by Arthur B. Butterworth of 300 De Queen Boulevard, Port Arthur, Texas, and has been tested on five ships with satisfactory results. The tanks are cleaned by machines that direct streams of water against the sides, top and bottom of the tanks.

The Texas Company tankers *Virginia* and *Pennsylvania* have recently been "gas-freed" by this system prior to the regular docking period and as both ships were carrying heavy Mexican oil a good test was made. Mr. Butterworth, with the assistance of Thomas Cor-

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nick of the marine department of the Texas Company, New York, and the crew alone were able to clean the ship while enroute from Providence, R. I., to New York.

While the vessels were being pumped out the cleaning gear was fitted up, cleaning water heated and everything made ready for the operation of the cleaning machines. Four tanks were to be cleaned at one time and no one was to enter the tanks at any time for the purpose of cleaning, all cleaning operations being accomplished by the machines.

Method of Operation

In the cleaning operations sea water is stored in one of the cargo tanks and is heated as hot as possible. In this case 160 degrees F. was maintained by means of heater coils located in the tanks. One of the cargo pumps draws the hot water from storage delivering it into a 2½-inch (temporary) pipe line on deck. A 1½-inch valve outlet is fitted in way of each tank opening or ullage hole.

The machines are installed in the ullage holes and are connected to the 1½-inch valves. A water pressure of 100 pounds per square inch is applied to the machines which are operated by air motor located at the upper end. At the lower end of the machine, which extends down into the tank 18 feet, are located two ⅝-inch nozzles. The motor located at the upper end turns these nozzles slowly in a horizontal and a perpendicular plane. No water is allowed to accumulate in the bottom of the tank while cleaning, this being stripped immediately and returned to the supply tank, pumped into a slop line or overboard. The reason for keeping the bottoms stripped is to take advantage of a continuous flushing effect which is one of the most important features in the cleaning operations, due to the fact that the tank bottoms are the most important part to clean.

The machine does not spray but directs two slow moving nozzle streams against the sides, top and bottom of the tank. The flushing is kept up for four or five hours in each tank and pipe lines, valves and fittings are thoroughly flushed out.

This method of gas-freeing presents certain advantages over the steaming method in that it is claimed to be more satisfactory in actual freeing. Fewer men are required to do the job and it is said to be unnecessary to send men into the tanks to clean, scrape and wash the interior.

Vibration of Oil-Fired Boilers

By Earle S. Nason

IN boiler operation, when burning fuel oil with mechanical pressure atomizers, boiler panting and vibrating frequently occur. If this condition is permitted to last very long, the boilers are liable to serious injury. The noise seems here, there and everywhere and no place in particular. The boilers shake, pant, hum and continuous vibration takes place, shaking bricks from the walls, cracking and loosening arches and other parts. In all cases this can be attributed to improper firing. The following are the general requirements for efficient firing of an oil-fired boiler:

(1) Oil supply: Supplying the proper quantity of oil to obtain the desired rate of combustion.

(2) Air supply: Supplying the proper quantity of air to support combustion of the oil burned; reducing air to a minimum.

(3) Mixing of air and oil: Finely atomizing the oil just prior to its coming in contact with the air for combustion and thoroughly mixing the air for combustion with this oil.

(4) Maintaining of furnace temperature: Maintaining a high furnace temperature necessary to assist in obtaining complete combustion. (Accomplished by use of sufficient refractory surface in the construction of the boiler.)

Insufficient air supply is the real cause of this evil and fortunately can quickly be detected. Volumes of black smoke roll out of the smokestack while the vibration is taking place. Increasing the air supply so that the flame in the furnace is a dull to bright orange color and a thin light brown haze of smoke rises from the stack will correct the trouble.

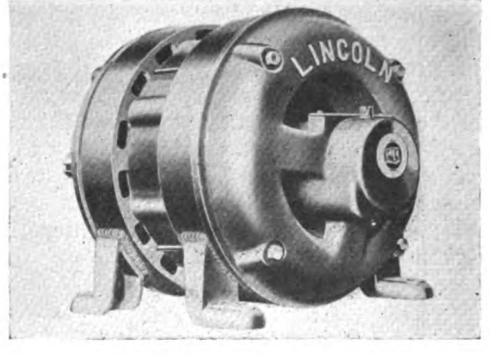
The air supply should not be increased at too fast a rate for then an excessive air condition is created preventing proper combustion which is the most serious and most common cause of low boiler efficiency in present day practice.

Sometimes from observation the combustion appears nearly perfect, yet the boiler will vibrate. The cause in such cases is generally poor design of burners and cones, whereby the air is restricted from properly mixing with the oil. In such cases it is found necessary to adjust burners by setting them further in and enlarging the radius of the cones.

New "Switch Start" Motor

THE Lincoln Electric Company, Cleveland, Ohio, announces a new "switch start" motor which is built in sizes from ½ to 30 horsepower and for either 2 or 3 phase, 60 cycle current. The motor is of welded steel construction and is equipped with sleeve bearings, although ball bearings may be supplied.

It is claimed that the motor may be started directly across the lines without the use of a compensator or resistance, while the current remains below the National



Lincoln "switch start" motor

Electric Light Association requirements. No sacrifice has been made of power factor efficiency, maximum torque or temperature rise in order to secure low starting currents. Another feature is that the starting torque of from full load to 250 percent of full load is possible without excessive increase of current and sudden high overloads may be applied without stalling the motor. In addition to these features the temperature rise of the motor is quite low giving a cool running and long life characteristic.

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Modernization of Capital Ships

Thirteen battleships still to be modernized — Work should be completed in 1931

By Lt.-Comdr. G. C. Manning, U.S.N.

THE Reduction of Armaments Treaty, signed in Washington February 6, 1922, which established the now famous 5-5-3 ratio of naval strength in capital ships for the United States, the British Empire and Japan in Chapter II, Part 3, Section I, contains the following provisions:

"(d) No retained capital ships or aircraft carriers shall be reconstructed except for the purpose of providing means of defense against air and submarine attack, and subject to the following rules. The Contracting Powers may, for that purpose, equip existing tonnage with bulge or blister or anti-air attack deck protection, providing the increase of displacement thus effected does not exceed 3,000 tons (3,048 metric tons) displacement for each ship. No alterations in side armor, in calibre, number of general type of mounting of main battery shall be permitted except:

"1. In the case of France and Italy, which countries, within the limits allowed for bulge may increase their armor protection and the calibre of the guns now carried on their existing capital ships so as not to exceed 16 inches (406 millimeters) and

"2. The British Empire shall be permitted to complete, in the case of the *Renown*, the alterations to armor that have already been commenced, but temporarily suspended."

One thing which stands out in one's mind after a careful study of this part of the Treaty is that its purpose is to limit the alterations which may be made to capital ships to increase their defensive powers. The only exception to the acceptance of the *status quo* principle for capital ships is that retained tonnage may be provided with additional means of defense against aircraft and submarine attack within certain limitations. It is certainly the intent of this provision that the improvement of the defensive powers of pre-Jutland tonnage is to be subjected to limitation. It is not the intent of this provision to permit any improvement in the *offensive* powers of retained tonnage. The purpose of the Treaty was to eliminate competition in capital ship construction between the contracting parties. Only one exception is taken to this principle, viz. subject to definite limitations the defensive powers of retained capital ships against attack by aircraft and submarines (no mention of battleships) may be improved. The implication is that no improvement in the offensive powers of these ships is authorized for, if it were the object of the Treaty, the suppression of competition in capital ships is largely nullified.

Elevation of Main Battery Guns

Admiral Farragut is credited with the statement that "the best protection is the well-directed fire of your own guns," but the ordinary conception of the main battery of a capital ship is that it is the agent of offensive action. Increasing the angle of elevation of the main battery can by no stretch of the imagination be conceived to be a measure to improve the ship's powers of defense against aircraft and submarine attack. It is primarily a measure to improve the offensive powers of the ship, although it also does improve the ship's ability to defend herself against other capital ships. It is, therefore, the author's opinion, regardless of any juggling of words, that increasing the angle of elevation of the main battery guns of our capital ships is incompatible with the spirit of the Reduction of Armaments Treaty and this nation should therefore renounce any intention of making this alteration.

Of the 18 battleships retained by this country, in accordance with the provisions of the Reduction of Armaments Treaty, only 5 have adequate protection against attack by aircraft and submarines. In other words, there are 13 battleships which should be modernized. Construction of battleships to replace the *Florida, Utah* and *Wyoming,* our oldest retained battleships, may in accordance with the Treaty be begun in November 1931. The earliest date that these replacement ships may be completed is 1934. When they are completed the *Florida, Utah* and *Wyoming* must be destroyed in accordance with the provisions of the Treaty, Chapter II, Part 2. If replacement ships are started in 1931, the destruction of the *Florida, Utah* and *Wyoming* must be started in 1935 regardless of the state of completion of the replacement ships at that time.

Replacement of Retained Capital Ships

Since any improvement of the offensive powers of our retained capital ship tonnage is incompatible with the spirit of the Treaty, the only way in which the offensive power of our fleet can be strengthened is by replacing retained tonnage. The desirability of improving the offensive powers of our fleet is regarded as too patent to require proof. It therefore follows that the United States should replace the retained capital ships at the earliest date permitted by the Reduction of Armaments Treaty.

Once we accept the proposition that retained capital ships should be replaced by the earliest date permitted under the Treaty, the desirability of completing the modernization program before that date becomes apparent. In concrete terms this means that our modernization program should be completed by November, 1931.

Attitude of the American People

The American people resent the necessity of expenditures to maintain a Navy. They realize that this nation must have a Navy and that it should be maintained at the strength authorized by the Reduction of Armaments Treaty. Recognizing these facts, they approve the action of their Congressional representatives in appropriating public funds for this purpose, but they give grudgingly. Their attitude is that it is up to the Navy to prove the necessity for the appropriations asked and they wish to be certain that the nation is going to get a hundred cents worth of Navy for every dollar appropriated. The public attitude cannot be called hostile, but it certainly is not characterized by full and complete confidence in the Navy. Whether or not this attitude is justified will not be discussed here but it is submitted that such is the attitude of the public and this being so it should be taken into account.

In dealing with the future one can only express an opinion; a prediction is merely an expression of opinion. The author ventures the opinion that no Congress

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will appropriate money to carry out major alterations to a battleship when we are already building battleships and at the end of a definite period of time the ship to be modernized will be scrapped. Neither does the author believe that the Congress will authorize funds for new construction until the modernization program is completed. Since modernization improves only the defensive powers of our capital ships, and the only way we can augment the offensive abilities of the fleet is by replacing old capital ships, the necessity of scheduling our modernization program to bring it to completion by November, 1931 is clear.

The modernization of the 6 coal-burning battleships has been completed. Seven more ships remain to be modernized. It required 30 months to carry out the work of major alterations on the coal-burning battleships. The appropriation for work on the *Nevada* and *Oklahoma* has just been made. Assuming that work will start January 1, 1928, we have 46 months to complete the 7 remaining ships. Assuming that the time per ship will be about the same as it was for the 6 coal-burning battleships, it appears that this length of time will be just about right if we continue at the same rate, but it does not seem probable that the program of major alterations can be completed by November, 1931 if we now slow down from 3 to 2 ships at a time.

French Shipping and Shipbuilding

Year 1927 characterized by expansion of operations and decrease in shipbuilding

TAKEN as a whole, the condition of French steamship companies in 1927 was relatively satisfactory and a little better than for the preceding year. The actual stabilization of the French currency due to the wise and strong policy of M. Poincaré was to a great degree responsible for this general improvement in the shipping trade as well as for that in most other industries. The consequent halt in the rise of living costs at last put an end to the demand for higher wages on the part of seamen. Fuel costs and other operating expenditures have remained at a fixed level for some time. The enforcement of the 8-hour working day in the French merchant marine has continued to exert a detrimental influence since other countries have not adopted this course.

While expenditures have ceased to increase, the earnings of most companies have been rather satisfactory in both the passenger and cargo departments, thanks to the arrangements made by several firms to establish points of departure at foreign ports such as Hamburg and Antwerp. The ever growing attention paid to comfort and luxury on passenger liners has also brought about substantial results.

While French shipowners made strong efforts during 1927 to improve business without any assistance from the state, they were unable to increase the total French merchant tonnage in service. In fact the tonnage showed a slight decrease for the period.

The French merchant tonnage which in 1914 aggregated 2,566,000 tons gross and which dropped to 1,178,000 tons at the end of the war, had increased to 3,500,000 tons by 1923. For the last three years there has been a slight diminution (about 80,000 tons) and it is likely that when the final records for 1927 are available, the figure of 3,400,000 tons will hardly be attained. This is due to the nearly complete stoppage of orders for new ships in the course of the last two years.

The Ship of the Year

Important developments featured the activities of the greatest French shipping undertaking, the Compagnie Générale Transatlantique (French Line) during 1927; first, this company was threatened with a possible transfer in the control of the firm as a result of the extensive purchases of shares made by a German concern. To prevent such an eventuality the board of directors decided to issue special new shares with multiple voting power. The outstanding event of the year as far as the French Line, and in fact the whole French merchant marine were concerned, was the completion of the largest French vessel, the new 42,000-ton steamship *Ile-de-France,* which sailed on her maiden voyage to New York on June 22. Now that this ship has been in operation for about 6 months, it is possible to state that she has proved entirely successful. Both the comfort of the accommodations and the excellent working of the turbine machinery, which is capable of giving a service speed of over 23 knots, make the ship a profitable undertaking. There is at present much speculation in connection with the forthcoming organization on the *Ile-de-France* of an airplane service. When plans have been completed, airplanes launched by catapults will be used to shorten the voyage for the mail and for some passengers who wish to speed up the voyage. The planes will leave the ship when about 10 hours from the coast at the end of each crossing.

With the 3 de luxe liners *Ile-de-France, Paris* and *France* and with the cabin class vessels *De Grasse, Rochambeau* and *Suffren,* the French Line is now in excellent condition to meet foreign competition on the North Atlantic run. This position will be improved still more in 1932 when another liner to be larger than the *Ile-de-France* will be placed in commission. In addition to this new liner which is likely to be laid down by the end of 1928 or early in 1929, the company is contemplating further construction, including a new liner of the *De Grasse* type, a liner for Central American service, a liner for Mediterranean service and three modern cargo vessels for the Pacific lines. Special interest attaches to the fact that several, if not all of these new vessels will be Diesel driven. These will be the first motorships ordered by the French Line.

In connection with the Havre-New York service, it is interesting to note that the French Line has just sold for breaking up purposes, the old liner *La Savoie,* commissioned in 1901, which had a notable career.

Activities of Méssageries Maritimes

While the French Line is only contemplating orders for Diesel driven ships, the Méssageries Maritimes has resolutely gone in for the building of large motor passenger vessels. In addition to 7 new passenger liners

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delivered from 1925 to 1927, this company took delivery during 1927 of 2 more vessels, the *Athos II* and the *Chenonceaux,* thus making a total of 9 new ships completed since the end of the war. One of these, the *Théophile-Gautier,* was the first French motor passenger liner. The company has now under construction at the La Ciotat yards of the Sté Provencale de Constructions Navales a second motor passenger liner, the *Eridan,* for the Australia line. It was learned at the time of writing that this company will, in addition to the foregoing, order two motor passenger liners. One of these, for the Madagascar service, will also be built at the La Ciotat yards and will likely be fitted with Burmeister and Wain engines. The second, of larger dimensions, for the China line, will be propelled, like the *Théophile-Gautier* and the *Eridan,* by Sulzer engines.

The Méssageries Maritimes is thus showing an activity in the construction of new ships which is fully justified by the commercial success of this flag in the world's trade. A feature of the company's service is the round-the-world line through the Panama Canal, while the winter cruises in Mediterranean waters have proved a most valuable undertaking. It is noteworthy, that such special cruises are now in favor among French companies. Among others the French line during the present winter season organized several cruises from New York to the Mediterranean with the *France.*

Like the French Line, the Méssageries Maritimes was compelled during 1927 to issue shares with multiple voting power in order to avoid a transfer of control.

New Liners for South American Line

The third largest French company, the Chargeurs Réunis, passed through an active period during the year, following the extensive purchase of shares made to the account of another French steamship company, the Fabre Line. The board of directors had to retire, following an unfavorable vote and a new board including several heads of the Fabre Line was elected. Charles Chaumet, a senator and former minister for commerce, was appointed as new chairman, while Gaston Breton, who had done much to increase and improve the company's business, was maintained as managing director. The joining of the leaders of the Chargeurs Réunis and of the Fabre Line was one of the most important events in French shipping circles in 1927.

In view of the recent completion of an extensive post war building program, the Chargeurs Réunis has not ordered new ships, but has had the motor cargo vessel *Camranh* converted into a passenger liner and placed in service on the western Africa line after being renamed *Brazza.*

Important developments have taken place in the fleet of the associated company, the Compagnie Sud-Atlantique, which operates mail services between Bordeaux and Brazil-River Plate. The liner *Lutetia* has been reconditioned and converted to oil burning and similar changes are to be made on the *Massilia.* On the other hand negotiations have been brought to a favorable settlement with the state so that the company may shortly order two new 25,000-ton passenger liners for the above service.

No State Subsidy to French Shipowners

An important development of 1927 was the completion of the investigations of the committee, known as the Extra-Parliamentary Committee for the Merchant Marine, which had been appointed some years ago by the government with a view of making a wide inquiry into the condition of the French shipping and shipbuilding industries and of suggesting all measures that would tend to improve their status. The conclusions and resolutions of this committee were embodied in a most comprehensive report compiled by Deputy Charles Leboucq, which will for years hence constitute a first class reference. The findings of this committee did much to establish a satisfactory French shipping policy and to call the attention of the entire nation to the complicated problems of ocean trade.

The absence of any subsidy to shipowners continues to be a feature of this policy, as the annual payments made to several companies for the operation of mail services cannot be regarded as subsidies, but only as payments for expenses actually incurred in the transport of mail.

Extension of Dry Docking Facilities

In spite of financial difficulties, the chambers of commerce of most French ports have found a way to carry on important extension work, thanks to the enforcement of the Dawes Plan. The most interesting achievement in this connection was the completion of the new 25,000-ton floating dock built in Germany to the account of reparations in kind, which was placed in service at Bordeaux in September. The 1,040-foot graving dock at Havre, which was commenced before the war, was completed in October and in view of the fact that this new dry dock can accommodate the *Ile-de-France,* the *Paris* and the *France,* the French Line no longer has to send these 3 ships to Cherbourg or Brest to be dry docked.

Other outstanding port developments include those that are to be executed at Saint-Nazaire, which will permit the building at the Penhoet yard of liners of larger dimensions than the *Ile-de-France.*

Depression in Shipbuilding—Assistance Scheme

The year 1927 witnessed an exceptional depression in the French shipbuilding industry. During the first 11 months orders both from French and from foreign shipowners practically ceased. Foreign orders, which for the last three years had included about 30 ships aggregating 140,000 tons, were quite stopped as from October, 1926, owing to the revaluation of the franc. Further, French companies placed no orders for the same period, hence a serious crisis in the shipbuilding trade occurred. One of the results of this depression was that one of the largest yards, the Chantiers de la Gironde, had to go into liquidation.

Six notable merchant vessels were delivered in the course of 1927, while only six ships were launched during the whole year. At the end of 1927, there are 12 notable vessels on the ways and 6 completing afloat, making a total of 18 ships of which 12 are being built for foreign owners and only 6 for French companies. Of these 18 ships, there are 12 motorships (3 French, 9 foreign), and 6 steamships (3 French, 3 foreign).

Shipbuilders Against Dawes Plan

From October 1926 to November 1927, French shipbuilders did not book a single order for a merchant ship, the only contracts placed being for the building of two Yugo-Slav submarines. Conditions were somewhat improved by the end of the year when the Compagnie Fraissinet placed orders for three small passenger vessels (85 meters long) for the Corsican service. One of these ships has been ordered from the Ateliers et Chantiers de Bretagne, another from the Chantiers et Ateliers de Provence and the third one from a German yard under the heading of reparations in kind. It is noteworthy by the way that the application of the Dawes Plan to

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shipbuilding is quite unpopular among French shipbuilders who are quite deprived of work and they have undertaken a strong action against this scheme.

The acuteness of the shipbuilding depression has at last driven the government to consider active steps to assist this industry. Because the present financial condition makes it impossible for the state to grant direct subsidies to shipyards, another scheme known as the "Credit Maritime" has been drafted. According to this scheme, the Credit Foncier, a banking organization dealing chiefly with mortgages and loans on unmovable property, will advance to shipowners moneys up to a total amount of about 1 milliard francs for 5 years (to be reimbursed within 20 years) at a rate of interest of only 4 per cent. The other 4 per cent required will be paid by the state. This scheme has not yet been approved by Parliament at the time of writing and its achievement is likely to be the outstanding event of 1928 as far as the French shipping and shipbuilding industries are concerned.

Progress of the Diesel Engine

Passing to marine engineering it is noteworthy that while continuing to have great confidence in steam drive (as was evidenced by its extensive adoption on many new liners and notably on the *Ile-de-France* where the Prudhon-Capus type of boilers was used to provide for accelerated circulation) French shipowners have at last gone in for motorships as stated above. Up to the present there are 5 French ocean going vessels in service fitted with oil engines, while 5 are building or on order. The delay of France in this respect is due to several reasons, not the least being the question of oil supply and future price. This uncertainty is more or less tied up with the French oil policy, action in connection with which was started the first of the year when the government took over control of oil imports and sales in this country.

In spite of the slow adoption of Diesel engines by French shipowners, the Diesel engine building industry has made steady progress on this side during 1927 owing to the many orders for engines to be fitted on foreign merchant vessels and on French and foreign warships. It is interesting to observe that all Diesel engines built in French works for merchant vessels are either of Sulzer or Burmeister and Wain type.

Assistance from Naval Orders

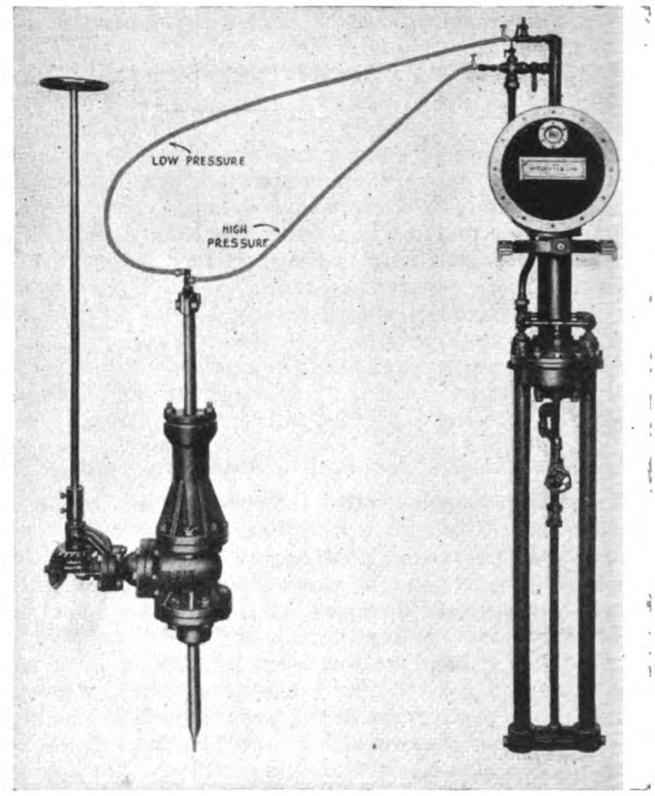
While supplying private shipyards with much needed work in accordance with the development of the post-war naval program, the French Navy stimulated Diesel construction by ordering in 1925 two 8,500-ton motor tankers. This order was in addition to those placed for 3 flotilla leaders, 4 torpedo boats, 6 submarines and 1 aviation tender. Each of the new 1,500-ton submarines on order will be fitted with 2 Diesel engines of 3,000 brake horsepower each. The Navy took delivery during 1927 of a number of new warships including the two new 10,000-ton cruisers *Duquesne* and *Tourville* each driven by machinery developing 120,000 horsepower.

Pitometer Log Records Speed and Distance

THE Pitometer Company of New York has developed a device for automatically measuring and recording the speed of ships as well as the distance traveled. By using the principle of the Pitot tube and obtaining a dynamic and static head, the speed of the ship may be determined.

A rod meter supporting two tubes composing the dynamic and static orifice extends through the bottom of the vessel and projects at such a distance that it may reach water unaffected by the movement of the vessel. These tubes transmit the dynamic pressure due to the velocity of the ship and the static head to a differential mercury manometer which is calibrated so as to register the speed of the vessel in knots.

A float, with rack attached, is located in the float chamber of the manometer and rises and falls with the mercury. This acts through a gear to a dial that is



Sea cock and rod meter connected to the differential manometer

graduated in such a way as to indicate the speed directly. This is the master dial and is designed to make a revolution of about 340 degrees for a maximum speed of 35 knots.

The dial is graduated as a square root function of the speed, which gives larger intervals for higher speeds and small intervals for low speeds. At cruising speeds, however, the dial has such small intervals that its accuracy is affected. This fault is corrected by the addition of two large mercury pots to the manometer, which on the opening of a valve changes the ratio of the manometer. Thus the dial will record its maximum at 17.5 knots instead of 35 knots and all other readings will bear a 2 to 1 ratio.

In conjunction with the hydraulic equipment, an electrical apparatus is operated to integrate the speed of the vessel into distance traveled by means of a master distance recorder and to transmit the speed from the master dial and the distance traveled from the master recorder to speed indicators and recorders located at desired stations in the ship.

The electrical instruments are operated from the master dial through a double contact wheel attached

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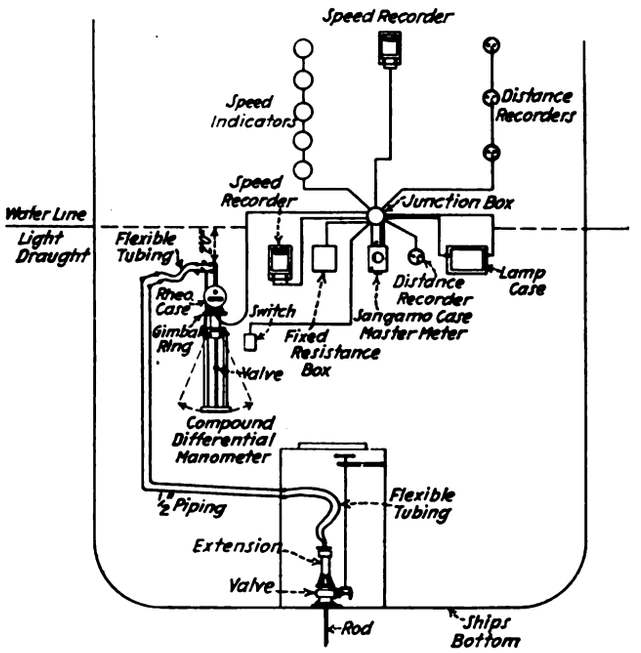
to the back of the dial plate. This wheel travels over a series of contact bars connected to resistances forming the log rheostat which is placed in one side of a divided circuit supplied with a uniform direct current. This log rheostat causes the current to divide so that the current flowing through the master distance recorder will be directly proportional to the speed of the ship. The master distance recorder is an ampere hour meter designed to register nautical miles at a rate of 0.289 ampere hours per mile.



Schematic diagram of Pitometer log

The several distance recorders located in different parts of the ship are operated in series from a separate circuit controlled by the master recorder. The moving element in the meter makes an electrical contact every tenth of a mile, sending a current through the distance recorder circuit, which causes these recorders also to register a corresponding distance.

Speed Indicators

The speed of the ship as indicated on the master dial is repeated by means of speed indicators and speed recorders which are non-recording and recording voltmeters connected in parallel across a portion of the fixed resistance. The voltage drop in this branch of the divided circuit varies directly as the speed of the ship so that these meters follow the master dial readings at all times.

Since the master dial rotation is the same for high or low speeds, the electrical system must be compensated to allow for this difference. A switch located near the manometer controls the operation of the electrical instruments and must operate in conjunction with the manometer valve. The operation of this switch does not affect the working of the divided circuit, but it doubles the number of impulses imparted to the distance recorders by the master recorder; thus they register twice the distance which is being integrated by the master recorder according to the inner scale position of the master dial.

The entire system is balanced and adjusted by means of ballast lamps and a fixed resistance box which is adjusted to give a proper resistance for the whole circuit.

Dock Power Plant to Supply Ships and Crane

AN automatic power plant to supply electricity for the operation of a 350-ton crane, soon to be installed at the navy yard at Puget Sound, Washington, will also supply power for ships berthed alongside the fitting-out pier. This will be the first installation of its kind to be made by the Navy Department and will mark an innovation in marine practice. Naval vessels, after docking and shutting down their propulsion power plants, will be able to "plug in" to convenient junction boxes to obtain sufficient electricity for lighting purposes, operating deck machinery and any other requirements which arise when large naval vessels are at the pier.

Two 800-kilowatt, 3-unit, direct current, motor generator sets of General Electric design will be installed to operate with full automatic equipment which will give constant protection and instantaneous service. Two 900-kv-a. synchronous motors, taking power from a 2,300-volt, alternating current cable running from the central power plant, will drive the generators. The direct current generated by the two motor generator sets will be supplied to various watertight junction boxes to which the ship's cables can be connected.

The substation will be entirely automatic, being normally locked to prevent admittance. A small switch in the main generating plant of the navy yard will control all operation. When the switch is closed, the motor generator sets will start and deliver direct current at the proper voltages to the various junction boxes will be made in 30 seconds.

In operation, one of the motor generator sets will be started immediately upon the closing of the remote control switch—providing no abnormal conditions exist. The driving motor will be started through a suitable compensator and, when synchronous speed is reached, will be thrown directly on the line. The automatic equipment will then make the necessary connections for feeding the output of the direct current generator to the supply lines, automatically checking polarity, voltage and load.

If the proper operating conditions do not exist, the set will be automatically shut down, but will immediately start up again when the trouble is removed. Should trouble of a serious nature develop, the set will be shut down and "locked out" until an inspection is made and the lock-out removed.

No matter how heavy the load nor how widely and quickly it fluctuates, correct voltage will be maintained automatically—providing the capacity of the installation is not exceeded. Should the load on the single machine exceed a certain value for a predetermined time, the second machine will automatically start and take its share of the load. Should the load drop while both machines are running, the second machine will automatically stop.

With the two machines in operation, the first one will hold the voltage constant while the second will supply sufficient current to keep the load balanced on the two machines. Both machines will be so arranged that, if the load reaches more than the capacity of the station. the current will be held constant and the voltage diminished sufficiently to prevent overloading.

The equipment is being installed in accordance with plans and specifications prepared by the bureau of yards and docks, Navy Department, Washington, D. C.

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Safety Precautions Aboard Tankers*

General safety rules and regulations—Cleaning and gas-freeing tanks—Extinguishing oil fires

By Arthur M. Tode†

MARITIME nations have always been interested in the question of safety of life at sea, although, probably, early sea regulations were at first more concerned with property than life. Property of enormous value in the maritime industry is destroyed and many lives are lost every year by fire. The prevention of such tragedies and of accidents to seafaring personnel and property on board ship is, therefore, one of utmost importance.

Considering the types of vessels engaged in carrying the world's commerce, practicable safety in their operation and accident prevention afloat, may roughly be divided into three groups: passenger liners, general merchant and freight vessels and tank ships. Whereas experience shows many similar marine accidents occur on all types of vessels, there are some safety precautions necessary to be observed which are peculiar to each of the three classes defined.

Tank Ships and Their Cargoes

Depending upon the service in which they are engaged the vessels of an oil company's fleet are designated as refined oil ships or as dark oil ships. The cargoes carried are classified as highly inflammable products (i.e. naphtha, naphtha distillates, all grades of gasoline, benzine and similar highly volatile products), inflammable products (i.e., light Mexican, South American and all domestic crudes), and less inflammable products (i.e., Panuco crude, fuel oils, gas oil, water white, lubricating oils and similar products which are but slightly volatile). Molasses, asphalt, cocoanut oil and creosote are included among other bulk cargoes transported in tankers.

Oil cargoes as carried in tank ships are generally considered a hazardous commodity, regardless of the nature of the oil. A cargo of high flash oil is, however, no more hazardous than carrying oil as a fuel, except that there is more of it. Additional precautions are necessary when transporting low flash and volatile oils as cargoes, but it is a fact that even fuel oil is volatile when heated, irrespective of the cargoes carried; therefore, certain precautions must be observed which may vary, depending on the grades and characteristics of the oil.

The real danger aboard tank ships is the fact that a fire starting anywhere in the ship may possibly ignite the engine fuel and cargo.

Characteristics of Petroleum Vapors

Certain characteristics of petroleum vapors have been established through scientific research, as well as the investigation of fires and explosions which have occurred on board ship. It has been found that certain crude oils and refined oils evaporate freely at ordinary temperatures. The vapors which result are heavier than air, and when mixed in certain proportions with air become highly inflammable.

Due to their greater density, the vapors rising from the surface of oil in a tank will not become diffused in uniform proportion with the adjacent air. Such vapor will tend to form a very rich mixture immediately above the surface and a leaner one at the top of the container. It has also been observed that such vapors, which in reality are fluids, may remain for a considerable length of time in the generating receptacle, or may flow unperceived for some distance in stream lines.

Investigations made by petroleum corporations have also proved that vapors given off from a petroleum product and diffused with air in a confined space result in a mixture which at first is merely flammable, burning rapidly when ignited but without audible explosion. Combustion takes place with greater rapidity, together with increasing volume of sound, as the proportion of vapor to air increases. If this is continued, the proportions conducive of violent explosions are finally reached. Thereafter, any further increase in vapor content will result in a reduction in the energy of combustion and flame of longer duration. From a flammable but non-explosive state such mixtures become explosive, followed by a flammable condition as at first.

Oil will not ignite except in the presence of air. The vapor or gas from the oil is, however, highly explosive when mixed with certain proportions of air. Oil or its vapors will not ignite of its own accord, but only by the application of heat of a higher temperature than its flash or fire points. However, the vapor will be readily ignited if brought in contact with a spark or flame. Oil vapor, being heavier than air, tends to collect in pockets in the lower part of the ship's tanks, double bottoms and adjacent spaces. Investigations have shown that oil upon ignition may tend to flare back to its source, in this way igniting an open tank from whence it came.

Flash Point and Fire Point

As the hazards of transporting oil are in proportion to the flash and fire points of the product, a more detailed explanation of these two characteristics will be of interest. If oil fuel is heated in an open vessel, vapor comes away in increasing quantities as the temperature rises, but this vapor will have no tendency whatever to light itself, i.e., there is no danger of spontaneous combustion. The vapor will not take fire unless a light is applied to it. If a light is applied at intervals to the surface of the oil, a condition is reached at which the vapor will give a sudden flame or flash of fire. This is called the flash test and the temperature at which this occurs is called the open cup flash point. If the oil is raised to still higher temperatures, a condition will presently be reached when the vapor takes fire upon a light being applied, and burns continuously. This is called the fire test, and the temperature of the oil is then known as the fire point.

In order to obtain more accurate measurements, the

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close flash test has been developed. This is a more precise method and has practically superseded the open flash test. In the close test, oil is gradually heated in a closed vessel, the mixture of vapor and air above the oil being well stirred up to make it uniform. A light is applied at intervals until at a definite temperature a flash is obtained, which is considerably below that of the open test. The open flash point is generally 30 to 35 degrees F. above the close test, and the fire test 45 to 55 degrees F. higher still.

Vapor is given off from oil in somewhat the same way as from water, until the air above the surface is "saturated," but it is not given off in considerable quantities until the temperature is within about 3 or 4 degrees of the close flash point.

General Safety Rules and Regulations

The operation of tank steamers and the repairs which must be made at periodic intervals are governed by features peculiar to this type of vessel. Quick turn arounds are absolutely necessary to the economical operation of tankers. Oil cargoes are rapidly loaded and discharged and a tank ship is apt to be in port only 24 hours for such purposes each trip. Another feature relates to the peculiar repairs which must be effected on oil tanks, oil pumps, oil piping, heater coils, etc., involving a large amount of oiltight work. Any gassy condition must be eliminated before repair work is started on deck, in the tanks, or in adjacent spaces. The combination of all these features makes the management of tank ships an exacting one.

Rules and regulations covering every possible hazard from fire and explosion have been promulgated by the several petroleum corporations. These regulations include every phase covering the safe loading and discharging of the vessels, precautions to be observed in the cleaning of cargo and fuel tanks preparatory to executing repair work, defects to be guarded against in electrical and mechanical equipment, rigid instructions against smoking, carrying of naked lights, etc.

Prevention of Boiler Room Oil Fires

The chief risks of fires on board all ships burning oil as fuel, whether passenger, freight or tank ships, are in the boiler room. These risks arise by leaks from valves or pipe joints, by faulty burners, or by incorrect manipulation of the burners. There are risks of fire and explosion due to percolation of oil and vapor through joints of the steel plating and by loosening of rust enabling leakage to occur, hence the fitting of cofferdams for safety. The vapor, and the oil itself, are liable to leak through riveted and calked joints of steel work, even though these have passed a good watertight test. The pipes for filling and emptying oil fuel, and the vent pipes, should be as short and direct as possible, and be so arranged that if any leakage occurs, dripping or any fine spray arising will not reach hot surfaces of the boilers, steam pipes, etc. The pipes for supplying oil to the furnaces should be carefully led in the same way, and all joints made metal to metal on these delivery pipes, in which considerable pressures exist.

In lighting up the boilers skill is required to avoid the formation of volumes of an explosive mixture in the furnaces and uptakes. Every precaution should be taken to prevent unburned oil from collecting in the furnace, as the hot brick gasifies it and there is serious danger of a flareback and a violent explosion. Proper precautions will eliminate such dangers. No matter how hot the furnace may be, if all burners are temporarily secured, no attempt should be made to relight from the incandescent brickwork. Very serious accidents have resulted from this practice.

The oil must be quite free from water or from sediment of any kind, as these may cause the flames of the burners in one furnace to be momentarily extinguished while spraying will still continue, and immediately afterwards the mixture may be fired by explosion. The burners must be maintained in a clean, efficient condition to avoid stoppage by carbon deposit, and also to prevent dripping, both of which lead to difficulties involving fire risk. The fire rooms should be kept scrupulously clean, and no old clothes, rags or pieces of wood which would absorb oil should be allowed to remain in case of a burst of flame from any cause. Drip pans should be provided in front of the boiler furnace and under the fuel pumps and should be kept in clean condition. Where boiler room bulkheads are covered with insulation, an inspection should be made from time to time to ascertain that no fuel oil has leaked through into the insulating material, thus constituting a fire menace. The bilges in the boiler room and pump rooms should be thoroughly hosed out frequently and all oily bilge water should be immediately and completely removed.

Excessive temperature of oil to the burners is another source of danger because the tendency of oil to leak increases with rising temperature. In most mechanical atomizing systems the oil is heated above its fire point, the only factor of safety being that it is not in contact with air until it reaches the burner tips. Excessive oil pressure is also dangerous, due to the possibility of some part of the system bursting. The relief valve which is provided for safety in this system should be adjusted for the desired pressure and, together with the thermometer and gages in the oil discharge lines, should be checked for accuracy at regular intervals. Another important factor in fire prevention is avoidance of soot accumulation in the uptakes and stacks. Proper regulation of burners and frequent use of mechanical soot blowers will minimize such accumulations. Cooperation should exist between the deck and engine departments regarding the best time to blow tubes. This operation often results in burning masses of soot flying from the stack and landing on the decks, and ships are frequently headed into the wind when tubes are being blown.

Precautions When Loading or Discharging

Oil cargoes are pumped into and out of tankers through flexible hose connections. For the purpose of grounding static electricity generated in a vessel and thereby eliminating sparking at the cargo connections when connecting or disconnecting the hose, an electric short circuiting device is usually provided. All scuppers from which a spill might flow are plugged oiltight with wooden plugs. While vessels are loading or discharging flammable products, the tank tops are kept closed and the tank top dogs slacked off and thrown back. The ullage plug holes on the cargo tank tops are covered with a fine mesh wire gauze or wet gunnysacks until the ullage plugs are permanently secured in place. Loading certain petroleum products "overall" (that is, with an open end of hose inserted in an open hatch or manhole) is a dangerous procedure on account of the gas generated. Lubricating oils, having a high flash point, are commonly loaded in this fashion with entire safety.

The overflowing of a tank when loading cargo is a

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very serious occurrence and a matter which is carefully guarded against. Some serious accidents in the past can be directly attributed to neglect in this respect. Besides danger of explosions and aside from the fact that the presence of floating oil in the vicinity of a ship is a direct menace to the vessel, tank overflows frequently cause undesirable and injurious pollution of adjacent waters, and is a direct violation of harbor ordinances.

When loading a vessel the several tanks are carefully watched and frequently gaged. When the cargo enters the expansion trunk, the purpose of which is to provide a confined space at the top of a tank to limit the free surface, the rate of loading is reduced and every precaution taken to prevent an overflow.

The bursting of a hose when loading or discharging is another serious matter. This is guarded against by maintaining the proper pressure on the cargo pumps, as well as by visual inspection and pressure tests of the hose at regular intervals.

In some instances the loading of highly flammable products after dark or during severe electrical storms is prohibited. During such times all fires on board are extinguished and shore steam is used for the operation of auxiliary machinery and for the heating system.

On some ships gas-freeing pipes are fitted to each tank and carried up masts in order to allow gas to escape or air to enter should changes in pressure occur while at sea, due to changes in temperature; also when loading or discharging cargoes with the hatches closed. The arrangement permits the evacuation of dangerous gases in an elevated zone where cause for fire is but rarely found. It is usual to fit valves on these pipes, which are spring or deadweight loaded, and open either to vacuum or pressure; these avoid the unnecessary loss of vapor and do not open until a definite arranged pressure accumulates.

Most tank ships have automatic vent and vacuum valves fitted directly on the cargo tank hatch covers; these valves are deserving of careful periodic inspection to insure their being in good operating condition at all times. The openings of these vents or valves are covered with fine mesh copper wire gauze. It is a common failing which should be guarded against, to paint over this gauze, clogging it up completely and practically sealing the vent. The important function of the gauze is to prevent a fire on deck from flashing back into the tank, it having been found that a flame cannot penetrate a finely divided screen. Instances have been reported of tankers afire on deck, where gas emitted from the tank vents, due to the heat, burned as enormous gas jets without igniting the tanks. To minimize the danger of fire due to open ullage covers when loading or discharging cargoes, these openings are often fitted with fine mesh copper wire gauze screens serving as a protection against fire penetrating into a tank, similar to the vent screens.

Cleaning and Gas-Freeing Tanks

In order to prevent fires and injury to persons and property which may result when tanks are being cleaned or repaired, it is necessary to be assured that tanks about to undergo repairs or cleaning, and under certain circumstances their adjacent compartments, are free from sediment and dangerous or explosive gases. The real danger exists when oil has been pumped from the tanks. After finishing what can be done to clear a tank by the pumps there remains a quantity of oil, or oily sediment, which must be removed by hand. The tank may be thoroughly steamed out and then washed out by filling with water and pumping it out several times and every effort made to thoroughly ventilate it by means of windsails and portable fans, and yet oil vapor will remain.

This vapor is so much heavier than air that it hangs about in every recess of the framing. It is at times necessary to drive the air supply in with considerable turbulence, to stir up and wash out the vapor from these dead corners. Oil has a remarkable capacity for penetrating between the laps and joints of plating and framing, and is held there by rust and scale acting as a sponge. Oil so held, when the tank has been emptied and cleaned, is a source of vapor for some time and the utmost care must be exercised in cleaning and ventilating the tanks.

As a rule tank vessels are not delivered to a shipyard for repairs until all tanks are steamed, smothered and sealed, or until a gas-free certificate covering all tanks in the ship has been issued. When emergency dry docking is necessary and no tanks or pump room repairs are contemplated, the tanks are smothered with steam and sealed prior to the vessel's arrival at the yard, and so maintained until her departure therefrom.

The discharge of washings from cargo and fuel tanks or tank vessels as well as passenger or freight ships is usually done while the vessels are at least 50 miles from the nearest headland. This is in accordance with an agreement reached by delegates from 13 countries at the Preliminary International Conference on Oil Pollution of Navigable Waters held at Washington, D. C. during June, 1926. One of the important provisions of the draft adopted at this conference was to the effect that the discharge of oil or oily mixtures be prohibited within such areas if the oil content exceeds 0.05 of one percent; that is, if it is sufficient to constitute a film on the surface of the sea visible to the naked eye in daylight in clear weather.

American as well as foreign companies operating tankers are observing this provision. When the ships are enroute to a loading port or repair yards the various tanks which have been ballasted are drained into one tank and the mixture there retained until arrival at the port of destination, where facilities are provided for its disposal. In this manner a vessel can refrain from discharging oil within the 50-mile zone and still arrive in port with all tanks clean with the exception of the one tank in which the oily mixture from the ballasted tanks has been collected.

When tanks are prepared for steaming the cover and ullage holes are closed, but left unfastened, and steam at a line pressure of about 75 pounds is allowed to enter the tank through the smothering line for as long a period as considered necessary. Upon completion of steaming, the hatch covers are thrown open and a windsail rigged into the tank to create air circulation within, thus expelling gases and steam. In cases where the gas content of the air in the tanks is usually high, additional air is forced into the tanks by a portable blower and a canvas duct. Another system employs compressed air which is forced through suction and discharge manifolds on deck, into the tanks; this method has the additional advantage of clearing the cargo lines of vapor and creating good turbulence at the bottom of the tanks. The cargo pumps are also used at times to assist in the expulsion of the gases.

When windsails and blowers have been rigged, the process of washing down is carried on by means of hose connected to a hot water line, the main condenser

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overboard discharge being commonly employed for this purpose. The washing operation is extended from the top of the tank to the sides and beams, and finally the bottom is thoroughly flushed. Frequently after the foregoing has been accomplished, sediment still remains clinging to the bulkheads or structural members in the tank and a second steaming period and washing operation must be carried out. When the tanks have been properly washed they are wiped thoroughly dry by means of buckets, brushes, scoops and rags. Special care is exercised to flush adjacent pipe lines, and all suction and discharge valves are kept open up to the master valve on each side of the tank in question.

After this work has been carried out to the satisfaction of the officer in charge and the vessel proceeds to a shipyard, no repair work in the tanks or in their vicinity is permitted until the tank or tanks have been certified to be gas free by an outside chemist.

In order that no misunderstanding can occur when describing the gaseous contents of tanks on the certificate the only notations which appear are: "Safe for men," "Not safe for fire," "Safe for men and fire," and "Not safe."

"Not safe" is used when oil or dangerous sediment is present in the tanks or leakage from adjacent compartments may occur, or when the gas content of the air is greater than two-tenths of one percent. At such times men entering tanks must be equipped with life lines and gas masks and a constant watch maintained on deck for their safety.

Precautions While at Shipyard

In addition to ordinary repairs to hull and machinery periodically made in shipyards on all types of steamships, the tank ship requires repairs of a more or less special nature. This, as has been previously mentioned, is due to her peculiar construction involving much oiltight work on tanks, bulkheads, pumps, oil piping, heater coils, etc.

When it is necessary to drain a tank in dry dock, precaution should be taken to catch any mixture of oil and water to prevent it from spreading to the dry dock, When renewal of rivets is necessary, care must be observed to mark plainly dangerous compartments from the outside and in other ways to warn workers engaged on the repairs. Before any contemplated work to the cargo lines is undertaken, it is important to ascertain that these have been thoroughly drained and blown out, so that when lines are broken, compartments will not be flooded, whereby great risk may be incurred, especially if men are at work with torches of fire.

Ventilation of certain tanks is often necessary during the progress of work in the yard. There is always danger of oil vapor from oil seepings in the tanks, under rivet heads, etc., and it frequently happens that when a rivet is renewed flames burst forth around it.

The danger of fire due to spontaneous combustion must be guarded against on all ships. Waste material, particularly if wet with oil, must not be permitted to accumulate in confined spaces where oxidation of the flammable material may proceed with such rapidity that its temperature is brought up to the point of ignition.

Defective ship's wiring has been the cause of many fires. Whenever insulation is damaged by heavy weather or other causes, particularly where there is immediate danger of a short circuit, repairs should be immediately effected.

There are just two ways to extinguish fire. One is to cool the material below its burning point. This is usually accomplished with water, or a chemical solution consisting chiefly of water. The other method is to smother the fire by cutting off the supply of oxygen. Water is not very effective for the purpose of extinguishing oil fires because the burning oil floating on the surface of the water spreads as more water is applied.

It has been recognized that to deal effectively with an oil fire the air must be excluded by means of a "blanket" of steam, sand, non-combustible gas, or some substance that will stand up to and not be broken down or destroyed by the heat; the smothering effect must continue till the temperature has been reduced, otherwise the fire will again break out. The efficacy of the various fire extinguishing agencies mentioned is dependent upon the particular location and dimension of a fire. Small fires have been quickly overcome by sand; water is reported to have been successfully used in extinguishing fuel oil fires in some cases; steam is a valuable agency on account of its capacity to displace the air, while a most effective method is a system for discharging non-combustible gas into compartments where fires may threaten.

The fire fighting apparatus with which tankers are equipped, besides axes, water buckets, hoses, hand or portable extinguishers conveniently located about the ship, includes a steam smothering system in the boiler rooms and tanks, while on many modern tank ships an elaborate system for the discharge of inert smothering gas into the various compartments is installed. Carbon dioxide gas (CO_2), which is commonly employed for this purpose, is stored in a number of steel cylinders manifolded together in batteries, each cylinder containing about 50 pounds of gas, located in a convenient and protected place such as the compartment under the midship house. The engine room, pump rooms, cargo tanks and spaces protected are provided with leads through distributing valves from the common supply. The remote control release handles are located in a place accessible in case of emergency, such as the pilot house or flying bridge. In case of a fire in any one or more of the cargo oil tanks or fuel tanks, it is only necessary to pull the proper control handle in order to release a bank of cylinders, thereby discharging a large volume of high velocity gas into the compartment to extinguish the fire.

Fires in cargo oil and fuel tanks usually occur when the hatch covers over the expansion trucks are open. Experiments have shown that by the use of carbon dioxide it was only the expansion trunk openings which needed to be protected. Projecting of blankets of carbon dioxide gas across the opening cuts off the oxygen supply completely and causes entire extinction of a fire in a few seconds, the time depending upon the volume of air space between the blankets of gas and the burning oil level.

Importance of Education and Supervision

Fire prevention aboard ship being of most vital importance in every phase of a vessel's operation it is absolutely necessary that every possible precaution should be taken to insure all fire detecting apparatus and fire fighting gear being always ready for immediate and efficient service. The elimination of all accidents in the transportation of petroleum products will probably never be realized, but the elimination of hazards incident to its handling is within the bounds of possibility if accomplished with competent and trained personnel, proper methods and equipment.

Safety measures can be formulated, modern fire-fighting apparatus may be installed, and rules and regu-

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lations can be laid down, but they will be productive of little good unless every member of a ship's complement accepts his part of the responsibility and does his share toward the prevention of fires and accidents.

Steam Operated Temperature and Pressure Controller

TO meet the demand for temperature and pressure controllers, regulators and thermostats where compressed air is not available for the air operated type, the Tagliabue Manufacturing Company, Brooklyn, N. Y., has developed a steam operated controller which is based on the pilot valve principle.

In operation, the TAG controller utilizes a portion of the steam being generated to heat a mechanism which controls the opening and closing of a valve which in turn governs the temperature of the apparatus. The controller is advantageous where one temperature must be maintained to give the best results.

Power is obtained without waste from the pressure of the steam. Variations in this pressure do not affect the accuracy of control for the reason that it is not the entire pressure but a differential pressure above and below a diaphragm which is thus utilized.

By referring to Fig. 1 it will be noted that steam is allowed to enter the diaphragm chamber through the

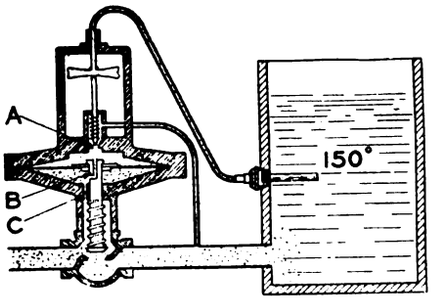

Fig. 1.—Controller in throttling position

opening *C* whether the steam valve is open or shut. Opening *B* connects the space above the diaphragm with the space below it. Steam can flow through this opening at all times in order that it may escape from the upper portion of the diaphragm chamber.

If the steam above the diaphragm is allowed to escape through opening *A* in Fig. 1, which is larger than the opening *B* connecting the space above and below the diaphragm, then the pressure above the diaphragm will be less than the pressure below it. This differential in pressure exerts an upward force sufficient to open wide steam valve against the pressure of the main spring.

When the steam is allowed to escape from the upper portion of the diaphragm chamber at approximately the same rate as that at which it passes from below to above the diaphragm, the differential is just sufficient to counteract the main spring to an extent which will cause the steam valve to be opened to an intermediate degree and thus provide a throttling control. With this general principle in mind, it is evident that the opening *A* through which steam escapes from the upper portion of the diaphragm chamber is an important one since its extent governs the opening, closing or cracking of the steam valve. In actual size it is a small orifice in which a pilot valve is placed. This pilot valve requires an insignificant amount of force for its operation. The valve is operated by a metallic bellows which forms a part of the usual thermostat system (sensitive bulb, connecting tube and bellows).

Operation of Valve

When the apparatus is at the correct temperature the valve throttles, which is the condition shown in Fig. 1. In this case the thermostatic liquid in the bulb is partly vaporized and exerts a moderate pressure through the bellows on the pilot valve which it opens. The rate of escape of steam from the upper portion of the diaphragm chamber is such that the differential

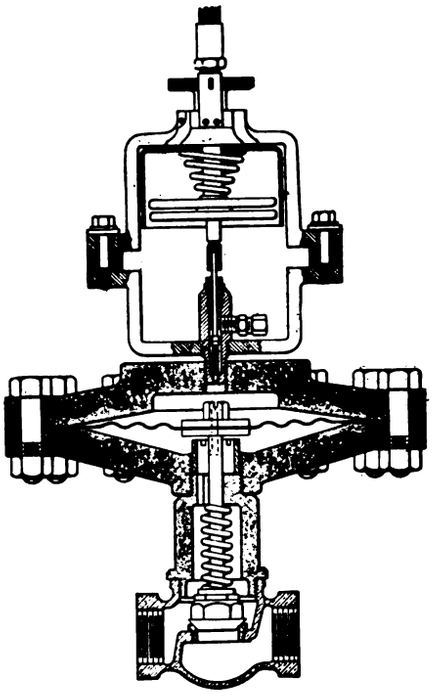

Fig. 2.—Cross section of direct connected temperature controller

opposed by the main spring maintains the steam valve at the correct opening. When the apparatus is too hot the main valve closes. Under these conditions the thermostatic liquid in the bulb is almost entirely vaporized and through the bellows exerts a pressure sufficient to close the pilot valve. The pressures above and below the diaphragm are thus equal which causes the diaphragm to become inoperative and permits the main spring to close the steam valve.

Under conditions where the apparatus is too cold the valve opens. This is brought about because the liquid in the bulb is not sufficiently vaporized to act on the pilot which is opened and allows the steam in the upper portion of the diaphragm chamber to escape faster than it can enter through the diaphragm opening. The pressure below the diaphragm is greater and the steam valve is opened wide allowing steam to heat the apparatus.

The apparatus is available in either direct connected, single systems of temperature controllers or pressure controllers and in double system temperature controllers and temperature humidity controllers.

This type controller is adapted in marine work to hot water service tanks, fuel oil pre-heaters, evaporators, feed water heaters and the like.

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Modern Trend of the Diesel Engine*

Low weight, high revolutions and high mean effective pressure characterize engine developments

By O. D. Treiber

ENGINEERS are now fast realizing the advantages of light weight, high revolution Diesel engines on account of space, weight, low first cost and low cost and ease in making repairs. Specifications once drawn limiting piston speed to 800 feet per minute are being rapidly revised. With modern developments in metals and the art of molding, casting, forging and forming them, with improved methods of bearing construction and lubrication, with light aluminum and magnesium alloys, high tension steel alloy castings and forgings, it is perfectly natural that improvements in lighter weight Diesel engines should be expected.

To be successful a Diesel engine must be reliable and long lived. The life and dependability of a properly designed, constructed and lubricated engine depend upon the proportion of working stresses to the destructive stress of the materials forming its parts.

A study of the stresses in both slow and fast running Diesels adds confidence to the durability of fast running engines when properly designed and built.

Diesels of light weight per horsepower embody the features of:

1. Light weight of material.
2. High revolutions per minute and high piston speeds.
3. High mean effective pressure may also contribute to further reducing weight by increasing output per unit of piston displacement.

These are three distinctive studies but somewhat correlated.

We will consider the study of light weight as pertaining to the design which eliminates unnecessary weight of metals and increases the stresses of the specially selected metals to higher unit limits than is common in slower and heavier engines.

Light Weight

Light weight from the standpoint of design gives the engineer a choice of:

1. General type—two or four cycle, single or double acting.
2. Arrangement of cylinders.
3. Section of metals.
4. Distribution of materials for highest efficiency.

In a study of the type, in order to select the trunk piston or crosshead type, two or four cycle, single or double acting, solid or air injection, there would undoubtedly be different decisions with different objects in view. All, however, involve one important controlling factor, that of revolutions per minute.

The two cycle engine admittedly cut out half of the idle strokes of the four cycle type and increases to some extent the power output per unit of cylinder volume, but unfortunately the two cycle engine requires outside assistance to scavenge and recharge itself. The time available for this very necessary operation is limited in the higher revolution engines and so a barrier is eventually reached which time and experimenting may ultimately master sufficiently to warrant its commercial use. Attempts have been made to produce a commercially satisfactory high speed, two cycle, double acting engine, but the time element for scavenging is difficult to master and as yet has not successfully been done to my knowledge.

The four cycle, double acting engine offers possibilities of increased power output per unit of weight but is quite impractical except in large units. Furthermore, the added weight of the necessary crosshead and piston rod adds materially to the inertia of reciprocating parts and again offers barriers to increasing the revolutions. The time lag of ignition is a factor to be reckoned with in high revolution Diesels. The time lag of ignition is the time between starting of the oil injection and the actual starting of ignition and is not to be confused with flame propagation with which we have to deal in carbureting engines using electric spark for ignition. Affecting this lag are:

1. Temperature of the air charge in the combustion chamber.
2. Pressure of the air charge.
3. Temperature of fuel during injecting.
4. Ratio of fuel atomization.
5. Surface tension of the fuel.
6. Percentage of hydrogen content in the fuel.
7. Shape of combustion chamber.

Attention is now directed to the single acting, trunk piston, four cycle type using solid injection. This type offers the greatest possibility for lowest weight of reciprocating parts, which is the most important factor in limiting revolutions.

The problem of heat control of the metals adjacent to the combustion chamber is purely mechanical and has no limitations within the present knowledge of the art.

High revolutions are limited principally by the weight of reciprocating parts. The inertia forces from these parts add materially to mean and maximum crank bearing pressures. Furthermore the reciprocating parts set up vibrations that can be resisted only by arrangement of cylinders and the stiffness of the engine framing. The inertia forces tend to rupture the connecting rod, connecting rod bolts, and also to lift the crank shaft out of its bearings.

Reduction of weight of reciprocating parts is limited by:

1. Selection of material.
2. Design to eliminate unnecessary weight within allowable stresses of these parts.

In the selection of materials for reciprocating parts the aluminum alloy for pistons is perhaps the most important. It permits a saving of approximately 60 percent over ferrous metal pistons. Furthermore, the heat is dissipated from the crown of an aluminum alloy piston several times faster than ferrous metal pistons.

Wrist pins must be carefully designed. The stress calculation is one of the most intricate of all engine stress analyses. Actual experience must prove the design if the lightest weight is to be obtained. A selected alloy steel, carefully case hardened, is essential.

* Abstract of a paper read at the thirty-fifth general meeting of the Society of Naval Architects and Marine Engineers, New York. November 11, 1927.

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Forged heat treated aluminum connecting rods have been installed with satisfactory results so far and save 40 percent of the weight of steel rods. However, steel rods with high physicals and high fatigue values are preferable pending exhaustive tests of the aluminum rods under operating conditions.

Steel rings are now a proven success. These parts are much lighter than cast iron rings, due to their lesser width, impractical in cast iron.

Magnesium alloys are now being tested for both piston and connecting rods. From present indications, success seems quite certain when much lighter reciprocating parts may be expected and this will result in higher revolutions than is possible with the metals we are using now.

We have with a given weight of reciprocating parts carried our study of limitations of revolutions per minute to the bearings. These bearings are limited in diameter partly by the peripheral or rubbing velocity on the one hand, but perhaps more definitelv by practical proportional dimensions for reasons of accessibility such as removing rods through cylinders, clearances and the increasing of weights of the bottom end bearing and lower end of rod. This increase of weight of lower end bearing and rod adds rapidly to centrifugal and reciprocating or inertia forces acting against the crank bearing to increase bearing pressures. The length of crank bearing is limited by the bending stress resulting from gas and inertia forces.

Crank shaft torsional vibrations of severe amplitude must be accurately predetermined in the building of high speed engines and the design arranged to eliminate fractured shafts from this cause.

The reciprocating and revolving parts thus establish our limits of revolutions.

Light weight per horsepower resulting from light weight of framing, cylinders and heads is quite a separate study. Considering first the cylinder liner: The use of heat treated alloy steel of 275 to 300 Brinell permits very thin sections with ample strength and also facilitates cooling of this member, as also the piston. Steel rings and aluminum pistons function admirably on steel walls. Aluminum alloy is a proven material for heads and saves about 65 percent of the weight of ferrous metal heads of equal strength. Cylinder water jackets and water exhaust manifolds can be made of tinned sheet copper and brazing flanges of cast bronze.

The framing of the engine serves three principal purposes:

1. To form a support and resist vertical and horizontal bending moments of the crankshaft.
2. To form an oiltight casing about the revolving and reciprocating parts.
3. To carry stresses between the crank journals and cylinder heads.

These parts have commonly been made of cast iron, the sections being extremely heavy to carry the stresses and facilitate casting. Stress limits are very low on cast iron, about 2,000 pounds per square inch being a safe working limit for engine framing. Cast steel heat treated framing with tensiles around 75,000 pounds per square inch reduces the weight of framing and increases the rigidity and strength. High tensile, heat treated alloy steel tie rods carry the stresses between the crank journals and cylinder heads. Distance columns of aluminum alloy form a support for cylinder heads and bracing. Cylinder heads are made square and bolted together in a fore and aft direction, thus forming a rigid truss member when the engine is considered as a unit for fore and aft rigidity, the base castings forming the lower chord and the heads as the other chord. Furthermore, vibration between cylinders is eliminated.

The cylinder liners and jackets are supported from the bottom of the head and protrude into the case fitted with a suitable gland to permit expansion and contraction freely. Aluminum covers and housings are quite as strong as cast iron and greatly reduce the weight.

For some commercial work, ferrous metal heads with copper jackets and manifolds will be used, as they are cheaper but heavier. A most satisfactory three-year test has established great confidence in the possibilities of aluminum alloy for cylinder heads when used carefully with a knowledge of its peculiarities in a salt bath with other metals.

The cost of producing light weight, high revolution Diesel engines on a pound basis will be higher than that of the heavier machines, but on a horsepower basis the high revolution engines will show decided advantages above 400 revolutions per minute. In a Diesel electric drive there is a weight saving over the direct drive of 40 percent where engines of 400 revolutions per minute are used with a propelling motor of 100 revolutions per minute. This weight reduction increases the earning power of the vessel an amount equal to approximately 10 percent per annum on the entire purchase price of the machinery. The simplicity of a two, three or four engine generator installation is attractive. The only auxiliary engines required are a small engine generator set of 40 to 50 kilowatts. One of the main sets supplies power for deck machinery when in port. In large vessels it is quite as feasible to install a large number of light weight engine generator sets as to install a large number of boilers. The first cost would be quite comparable with a modern steam installation, and the weight saving will be an important item. Furthermore, the exhaust gas heat will evaporate sufficient water to supply the ship's requirements for fresh water, both hot and cold. Thus additional weight is saved, resulting in further earning power.

While the high revolution Diesel electric drive is now possible and practical, we should not overlook the possibility of direct drive in high speed ships which the future will bring forth. Diesel engines of 20.000 to 30,000 horsepower, running from 250 to 350 revolutions per minute and weighing 30 to 40 pounds per horsepower, are not at all unlikelv in the near future, in fact are now generally within the present knowledge of the art.

Lighter Douglas Alexander Converted to Diesel Power

CONVERSION of the lighter *Douglas Alexander*, owned and operated by the Singer Manufacturing Company of Elizabethport, N. J., from steam to Diesel power has materially increased the freight carrying capacity of the vessel. Her dimensions are: Length, 107 feet 6 inches; breadth, 28 feet 6 inches; depth, 10 feet 6 inches.

A Nelseco Diesel engine of 500 horsepower built by the New London Ship and Engine Company, Groton, Conn., has been installed and it is expected that a speed of 12 to 13 miles per hour will be obtained. The engine is of the six cylinder, mechanical injection, four cycle, direct reversible type. Operating controls are so arranged that maneuvering may be carried out from either the main deck level or the engine room floor. Fig. 1 is

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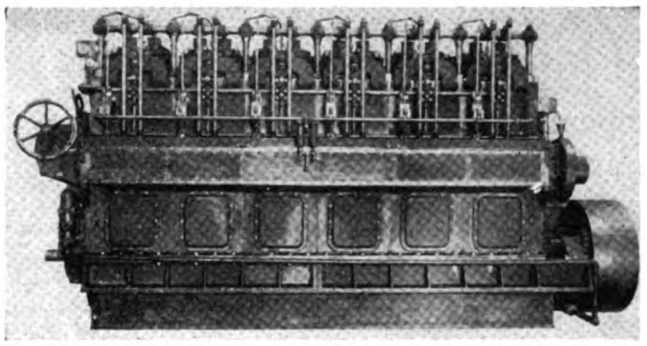

Fig. 1.—Nelseco 6-cylinder, direct reversible, 500 brake horsepower Diesel engine

a general view of the engine, although it does not show the new control arrangement.

The general arrangement plan of the *Douglas Alexander* with the Nelseco engine installed (Fig. 2) shows the small engine casing on the main deck, which directly increases the freight carrying capacity. This drawing also shows the simplified auxiliaries below deck. The increase in deck space is highly desirable as the Singer Manufacturing Company uses the boat for delivering large shipments of sewing machines to the foreign steamship lines around New York harbor.

Eads Johnson, naval architect, had charge of the conversion work, which was carried out at the W. & A.

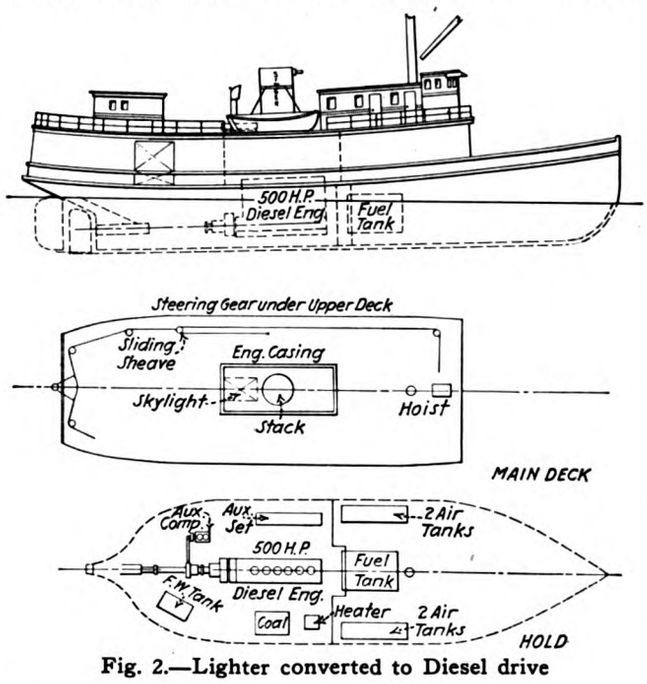

Fig. 2.—Lighter converted to Diesel drive

Fletcher plant in Hoboken, N. J. It is estimated that the resultant economies of the Diesel engine will pay off the initial investment involved in the conversion work in two to four years.

Merchant Marine Hearings

(Continued from page 191)

interest and yet they are carried on by means of private enterprise.

"We realize that members of Congress are striving earnestly for a sound and practical solution of our shipping problem. Congress is giving the Shipping Board many millions each year of the taxpayers' money to pay deficits incurred by agents who operate the ships on terms whereby they get their commissions and percentages of the gross receipts whether or not they show a profit for the Shipping Board. The incentive to invest private capital in better ships and facilities for the future is lacking. The handicaps inherent in government shipping make for failure in this business which perhaps more than any other calls for the ingenuity of private initiative. If the principle of the Jones bill is adopted the deficits from this losing government venture will continue indefinitely as an annual charge upon the American people.

"Besides its essential proposals covering trade routes and mail contracts provided for in Titles II and III, the White bill contains additional provisions in Title I regarding the construction load fund and provision in Title IV regarding naval reserve payments, which are designed to be of assistance to the upbuilding of a privately owned merchant marine.

"The bill, however, in Title V contemplates the establishment of a government operated marine reinsurance fund which we believe to be unnecessary and unwarranted in view of the marked expansion in private American insurance of this character in recent years. We believe that with continuance of the present policy these resources will continue to increase and meet all reasonable requirements of American shipping. On the other hand, to set up a government operated fund would retard this development. Therefore, we urge that the reinsurance provision be eliminated.

"We hope that Congress will decide for private enterprise as against continuation of government ownership. Drastic amendment of the Jones bill so as to provide constructive measures embodied in the White bill as outlined above would give new hope to American citizens who are working for the upbuilding of our private American merchant marine."

Manufacturers Submit Suggestions

Recommendations for the upbuilding of an American merchant marine, based on the opinions of manufacturers and interested shippers, and of builders, owners and operators of merchant ships, were submitted to the Committee on Merchant Marine and Fisheries of the House of Representatives by W. A. D. Evans, president and treasurer of the Cooper-Hewitt Electric Company of Hoboken, N. J., chairman of the Merchant Marine Committee of the National Association of Manufacturers.

These recommendations were offered as a composite of the various suggestions made in the present complex situation and their authors believe they will circumvent many of the detailed difficulties which have led supporters of a general shipping program off into irreconcilable tangents.

Briefly, the recommendations provide:

1. Encouragement of private ownership and ultimate exclusion of the government from ship operation and ownership.
2. Determination of the essential and most promising trade routes of the world and making long-term contracts with private operators for maintenance of adequate service.
3. Compensate these operators by paying a sum comparable with the average losses sustained by the Shipping Board in its present operation.
4. Provide for the recapture of a certain proportion of profits over and above a commensurate return on the capital invested, for the purpose of additional ship construction.
5. Provide for an equitable distribution of mail contracts to encourage cargo ship operation.
6. Extension of the Naval Reserve to provide additional operating personnel for the merchant marine.
7. Provide for a continuing ship-building program, in accordance with the best shipping knowledge of the day, with a construction loan fund which would provide loans for new vessels up to seventy-five percent of the total cost; additional funds to be obtainable from the United States Treasury with a low interest rate.

S. S. AMERICA EQUIPPED WITH KOLSTER RADIO COMPASS.—The Kolster radio compass which will guide the S. S. *America* in fog and storm is no stranger to her new commander, Captain George Fried. Just two years ago he and his crew on the S. S. *Roosevelt* were wildly cheered and decorated with medals in London and New York for their rescue of the crew of the S. S. *Anitnoe*. Twice Captain Fried trailed down the radio signals of the disabled British freighter by using his Kolster compass, finally rescuing her entire crew.

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Questions and Answers for Engineers

Practical information on the operation and maintenance of boilers, engines and auxiliaries

This department is maintained to help those who desire practical information regarding engine room problems or who are preparing to take examinations for a marine engineer's license. Readers are urged to send in questions. Inquiries bearing the name and address of the writer will be answered promptly by mail. If the question is of general interest the answer will also be published in an early issue of the magazine, although the identity of the writer will not be disclosed in doing so. Anonymous communications will not be considered.

Internal Inspection of a Boiler

Q.—What are the principal defects to be looked for when examining a boiler internally?

A.—The inspector should look for corrosion, pitting, broken staybolts, thin plates and bulges, and he should also be sure that fusible plugs are clean and in good condition.

Plugged Water Gage

Q.—What indications would show if a glass water gage stopped up?

A.—The water would remain stationary in the glass. If stopped up at the bottom, the water would gradually gain through condensation in the glass, but if stopped up at the top the pressure would fill the glass from the bottom.

Feed Pump Troubles

Q.—What causes trouble with a feed pump at times?

A.—The various causes of trouble with a feed pump are: The float in the hot-well out of order or stuck, broken packing rings in piston, or packing in plunger worn out, something getting under seat of valves, not enough water in hot-well or the water being too hot.

Effect of Changing Cut-Off

Q.—Please explain the effects of linking up and opening out of valve gears on a triple expansion marine engine; that is, its effect of either increasing or decreasing the power of the various cylinders.

A.—Changing the high pressure cut-off without change in its chest pressure changes the total number of expansion and affects the total power of the engine but has but little to do with the proportion of power developed by each cylinder.

Throwing the intermediate pressure or low pressure links in causes an earlier cut-off in that cylinder, thereby producing a higher initial pressure in the receiver, a higher initial pressure on the piston in question and a higher back pressure on the piston preceding it, all resulting in an increase of power in its own cylinder and a decrease in power in the one preceding it.

Throwing the intermediate pressure or low pressure links out causes a later cut-off in that cylinder which decreases the work of that cylinder and increases that of the one preceding it.

Clearance of Solid Piston Ring

Q.—What is the rule for the amount of clearance allowed for expansion between the ring and valve chamber of a solid piston ring of different diameters and steam pressures such as are used on some types of piston valves?

A.—It is good practice in fitting solid or plug type piston valves to make the total diametral clearance between the ring and valve chest liner about 0.0003 inch per inch of diameter.

Welding a Corroded Boiler

Q.—Can satisfactory repairs be made to corroded boiler plate by means of welding?

A.—It is believed that where such a condition exists, it is practicable to build up the plate to its original thickness by welding, but the area over which this is done should not be too great and the resulting thickness should be uniform throughout its entire extent.

Rebabbiting Bearings

Q.—What is the approximate amount of metal required to rebabbit bearings, assuming the length of bearing equals the diameter of shaft?

A.—A shaft 16 inches in diameter requires about 100 pounds of metal for each half of the bearing; 15 inches diameter, 90 to 95 pounds each half; 14 inches diameter, 80 to 85 pounds, and a shaft 12 to 13 inches diameter requires 70 to 75 pounds of metal for each half of bearing.

Lubrication of Turbine Gears

Q.—Please describe the practice as to the lubrication of turbine gears.

A.—There are at least the following two general methods and it may be that there are variations of both.

In the first method the oil is conducted from the reservoir to the contact line and is sprayed under pressure through nozzles directly into the teeth.

In the second method the pinion is arranged to revolve in an oil bath while at the same time an overflow is arranged to supply oil continuously on to the teeth just prior to contact.

Effects of Boiler Pitting

Q.—What parts of a boiler usually show the effects of pitting and corrosion both internally and externally, and why?

A.—Internal pitting or corrosion usually takes place along the waterline on shell, along the line of grate bars due to the difference in temperature at that point, below and above the fire line along the grate bars and on the extreme bottom of the shell and bottom combustion chamber, due to impurities from feed water settling where there is the least circulation. External corrosion on the shell is usually caused by leaky seams, or joints on valves, improper ash fenders around joints of boilers and check valves, neglect to keep the outside painted with fish oil or a metal such as bitumastic or asphaltum.

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Solid Injection

Q.—What is the meaning of the term "solid injection?"

A.—This term refers to the mechanical spraying of oil fuel into the working cylinder of the Diesel engine as distinguished from the more generally used method of atomizing the fuel and injecting it by means of compressed air at a pressure of some 900 to 1,100 pounds per square inch.

Soluble Matter in Feed-Water

Q.—Which is more dangerous to operate, a boiler with dense water carrying 50 pounds steam pressure or one carrying 200 pounds pressure, and why?

A.—A boiler with dense water carrying 200 pounds pressure of steam is decidedly more dangerous to operate than one carrying 50 pounds pressure, as the precipitation of the soluble matter held in suspension in the water is greater at 200 pounds than at 50 pounds steam pressure.

Piston Rings

Q.—When fitting cast iron piston rings in cylinders of different diameters and steam pressures what is the rule used by engine builders for the distance allowed between the butts of a ring to allow for expansion (least amount)? I have used the coefficient of linear expansion neglecting the expansion of the cylinder and it seems to give more opening than is necessary.

A.—The following formulas are recommended for use in the design of piston rings:

$$f = 3P \times \left\{\frac{D}{t}\right\}^2 \qquad (a)$$

$$C = 2.4 \times \frac{D^2}{t} \times \frac{f}{E} \qquad (b)$$

$$S = D \times \pi C (T_1 - T) \qquad (c)$$

where f = stress per square inch in ring;
P = pressure per square inch exerted on cylinder wall by ring;
D = bore of cylinder in inches;
t = thickness of ring in inches;
E = modulus of elasticity for cast iron = 15,000,000;
C = length circumferentially cut out of ring in inches (expansion not included);
S = space between ends of ring to allow for expansion;
T_1 = temperature of ring;
T = cold temperature of ring = 60 degrees F.

Efficiency of Shafting

Q.—Please give me a figure on efficiency of shafting.

A.—The following is taken from the American Civil Engineers' Handbook:

Item	Percent
Common bearing, singly	96 to 98
Common bearing, long lines of shafting	95
Roller bearings	98
Ball bearings	99
Spur gear, cast teeth, including	93
Spur gear, cut teeth, bearings	96
Bevel gears, cast teeth, bearings	92
Bevel gear, cut teeth, bearings	95
High-grade transmission chains	97 to 99

In the above tabulation it should be noted that the bearings for long lines of shafting are given an efficiency of 95 per cent. In the case of line and tail shafting losses in naval vessels the writer makes it a practice to use 97 per cent for the sake of uniformity. However, this efficiency is subject to a great deal of variation, depending upon the shaft alignment, the excellency of lubrication, and the tightness of gland packing.

In this connection, in the January 21, 1927, issue of *Engineering*, there occurs the following statement:

> The loss due to shaft friction was from 1 to 2 percent. A common allowance for that loss is 4 percent, but cases are known of the trial results being far below what was expected, and the losses were afterwards traced to the stern tube gland having been too tightly packed. The loss in one case was placed at as much as 10 percent.

J. L. Kent, in his paper on "The Effect of Wind and Waves on Propulsion of Ships," uses 5 per cent power loss in shaft friction. In the proceedings of the "Institution of Naval Architects," April 11, 1924, the same authority showed figures of from 7 to 9 per cent.

Lift of Pump Valve

Q.—When calculating the amount of lift of a pump valve (water end) should the area of the valve seat bridges be deducted from the area of the opening to find the correct lift?

A.—The area of the circumferential opening of reciprocating pump valves, water end, is in no way dependent upon the area through the valve seat. The diameter to be used in figuring the lift should be taken at the inside diameter of the valve seat. The bridges are considered only in calculating this latter diameter.

Duty of a Governor

Q.—What is the purpose and duty of a governor?

A.—The governor provides means for controlling the supply or amount of steam admitted to the cylinder, so that the average force acting on the piston will be just great enough to overcome the average resistance. It is also its duty to keep the speed of the engine practically uniform and prevent racing, running away or slowing down and stopping.

Lubricating Oils

Q.—In selecting lubricating oils for use on shipboard, what general rules should be followed?

A.—Lieutenant Commander Guisbert B. Vroom, U. S. N., discussed this subject in the April, 1925, issue of MARINE ENGINEERING AND SHIPPING AGE. The following points are taken from this discussion.

Specialized knowledge either on the part of the engineering staff or outside consultants must be utilized.

Machinery units should be listed carefully as to speed, bearing temperatures, clearances, feed, coaling systems, oil purifying and sizes of piping.

In the selection of oils, the most important and expensive machinery units should be favored.

The selection should be based purely on quality, and quality should be measured in terms of freedom from impurities and the high degree of viscosities. "Viscosity" is a measure of the ability to maintain the film under given conditions of pressure, temperature and speed of bearing. The best oil will be the freest from impurity which may cause far-reaching damage to expensive machinery and it will also be that oil which will best maintain lubrication under service conditions.

The number of grades of oil carried should be the minimum consistent with the tankage facilities and chances for contamination.

Once standard conditions are established, annual examination and check-up should be made looking to the effect on and condition of bearings.

Purchase should be made on specifications only; such specifications should be drawn entirely on known technical requirements.

A laboratory check should be made from time to time upon samples in order to insure maintenance of the standards set.

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Questions and Answers Relating to Ship Design and Construction

By J. L. Bates, Naval Architect, and W. B. Newton, Marine Engineer

This department is maintained for the purpose of answering all questions relating to ships and their machinery. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

Effect of Vessels Passing Close Together in Shallow Water

Q.—Why are vessels passing close to each other in shallow water drawn toward each other so that collision sometimes results?

A.—An explanation of this phenomenon was given in the October and November, 1927, issues of the *Scientific American,* in substance as follows:

What is known as the Principle of Bernoulli states:—

Wherever there is an increase in velocity of flow in a gas or a liquid due to a constriction, or the equivalent of a constriction, at that point the pressure is reduced.

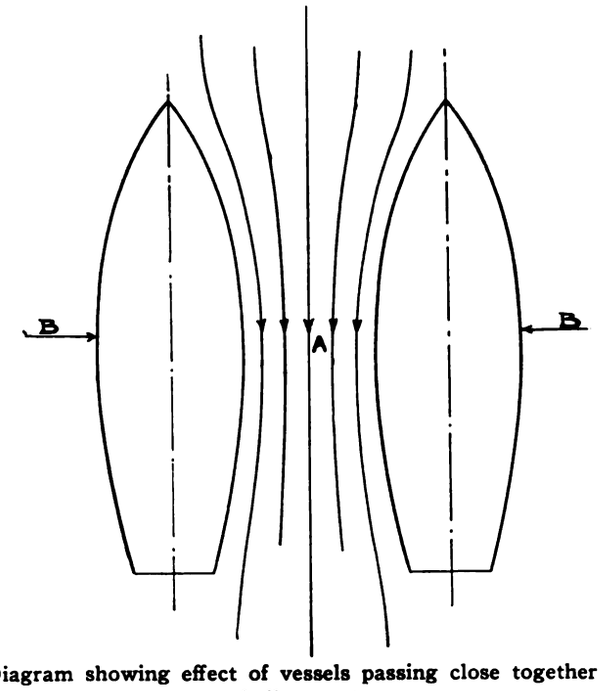

Diagram showing effect of vessels passing close together in shallow water

In the sketch two boats are shown anchored or moving side by side in a stream as near to each other as the width of one of the boats.

The water passes the boats along the lines of flow roughly indicated. The flow is constricted at point A. There results a lessening of pressure at A relative to that at B and B. This produces a tendency for the boats to approach each other.

Dimensions of Propeller

Q.—We have a tug boat 81 feet long, 21 feet beam, 9 feet 6 inches draft, hull lines very full, in which is installed a 13-inch by 26-inch by 18-inch stroke compound engine, carrying 250 pounds of steam. I would like to know the dimensions of a propeller for heavy towing that will hold this engine to 130 revolutions per minute towing. The diameter limit is 7 feet 6 inches. Also would like to know what is the approximate horsepower of this engine at 130, 140 and 150 revolutions, respectively. The engine runs, condensing, with 25 inches of vacuum.

A.—A partial answer to the above question has already been furnished in the March, 1928, issue. It remains to make some comments relative to the characteristics of the propeller.

As previously pointed out, the data furnished are insufficient for proper detailed consideration. The following should therefore be accepted merely as meeting with reasonable efficiency conditions which are considered to be probable.

It is assumed that the tug is to be capable of about 10 knots maximum speed when running free; that towing is to be done at speeds of from 5½ to 6 knots and revolutions under towing conditions averaging about 130 per minute; that a 4-bladed propeller is to be used; that, when running free, the revolutions are to be somewhat greater than 130, perhaps 150 to 155; that owing to the limit placed on propeller diameter (7 feet 6 inches), a wide tipped blade of the Dyson restricted diameter type will be used rather than the ordinary elliptical blade; and that a rather large projected area ratio may be accepted to secure moderate unit thrusts.

The tug boat propeller is usually designed having in view both the towing and running free conditions. A large diameter and low value of pitch ratio favor towing efficiency because of the low unit thrusts resulting. More moderate diameter and higher pitch ratios conduce to greater efficiency and higher speeds when running free. In the present case it is assumed that the emphasis is to be placed upon towing efficiency.

With the foregoing in view, it is believed that the characteristics following should give good results:

Number of blades	4
Basic diameter	8 feet 4 inches
Reduced or actual diameter	7 feet 6 inches
Pitch ratio	1
Pitch	7 feet 6 inches
Projected area ratio	0.45

Gap in Diesel Engine Piston Rings

Q.—What would be the proper gap in a 1-inch diameter piston ring used in Diesel work? Or what would be the proper ring pressure against the cylinder wall? Is there any formula covering this point? P. J. S.

A.—I have experienced some difficulty in obtaining satisfactory formulæ covering the question which you have asked, inasmuch as many of the writers on Diesel engine design do not touch on this question. The following material, which has been taken from Guldner's "Internal Combustion Engines," translated by Diederichs and published by D. Van Nostrand & Company of New York, is the best material which I have been able to find.

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The piston rings are usually cast iron *snap rings* of small width, fitted in grooves cut around the circumference of the piston. Special spring rings and detachable seats for the rings have not proved successful, as nearly all these special constructions lose their efficiency after a short time by burning fast or otherwise sticking, and because they usually require a greater thickness of metal in the piston barrel. Rings held out by springs also require a greater depth of grooves, the disadvantage of which has been pointed out above.

In general, the snap rings are made of uniform thickness. Eccentric rings do not possess any appreciable advantage, because the purpose for which they are used, that is, to obtain a uniform spring around the circumference, is not realized. On the other hand, they cost more to manufacture, and toward the joint the clearance between bottom of groove and the ring is seriously increased.

CONSTRUCTIVE DETAILS

Let the external diameter of the snap ring, when in place, be $D=2r$ inches (the same as the cylinder bore), let the mean radius of the ring be $rm=\frac{D-s}{2}$ inches, and let Kb pounds per square inch be the allowable bending stress. Then

$$\frac{r}{s}=\frac{D}{2s}=\sqrt{\frac{Kb}{12p}}+.5$$

in which p (in pounds per square inch) is the pressure of the ring against the cylinder wall. From this the required *thickness* s of the ring is

$$s=\frac{.5D}{\sqrt{\frac{Kb}{12p}}+.5}\text{ inch} \quad . \quad . \quad . \quad . \quad . \quad . \quad (50)$$

The allowable stress Kb in the dangerous section opposite the joint, may be taken fairly high, for cast iron from 12000 to 17000 pounds per square inch, because the stress is constant and acts always in the same direction. Snap rings, however, are under their greatest load when being stripped over the piston to slip them into their grooves. This is only possible as long as

$$\frac{rm}{s}=\frac{D-s}{2s}>\sqrt{\frac{E}{2.5Kb}}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (51)$$

in which E is the modulus of elasticity.[1]

If it is desired that the stress induced during the slipping on of the rings shall be the same as the stress during operation, we must have a thickness s of ring, assuming $E=11500000$ for cast iron, equal to

$$s=rm\frac{\sqrt{Kb}}{2145}\text{inch} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (52)$$

From these equations we find the following relation between $\frac{r}{s}$ and Kb, Table 11.

TABLE 11
PROPORTION OF SNAP RINGS TO STRIP OVER PISTON

$\frac{r}{s}$	20	19	18	17	16	15	14	13	12
Kb	11,600	12,900	14,500	16,350	18,450	20,900	24,300	28,300	33,500

The spring pressure, p, per square inch of circumferential area, with which the ring in place presses against the cylinder wall, varies from 3.5 to 7 pounds per square inch. Its amount does not appear to depend as much upon the value of the gas pressure to be confined as it does upon the rapidity with which the latter rises and falls.[2] For any given set of dimensions (see Table 12),

$$p=\frac{Kb}{12\frac{r^2m}{s^2}}=\frac{Kbs^2}{12r^2m}\text{pounds per square inch} \quad (53)$$

The *part to be cut out of the ring* at the joint may be made equal to

$$a=9.5\times\frac{D-s}{2}\times\frac{DKb}{2sE}=9.5\text{rm}\frac{rKb}{sE}, \quad . \quad . \quad . \quad (54)$$

$$a=9.5\times\frac{D-s}{2}\times k=9.5rmk. \quad . \quad . \quad . \quad . \quad . \quad (54a)$$

[1] The derivation of these equations is given by K. Reinhardt in the Zeitschrift d. V. D. I., 1901, p. 375. Tables 11 and 12 are taken from this very complete exposition of the question of piston rings.

[2] A means often resorted to on testing floors, when the piston blows through, is to conduct the pressure of the explosion into the grooves under the rings, to increase the pressure p. Needless to say, this means of "last resort" is wrong from all points of view.

TABLE 12
VALUES of p AND κ FOR VARIOUS VALUES OF $\frac{r}{s}$, $\frac{rm}{s}$ AND Kb, FOR SNAP RINGS

$\frac{r}{s}$	$\frac{rm}{s}$	Kb=	10,000	11,350	12,800	14,200	15,600	17,000	18,450	19,900	21,300
20	19.5	p	2.17	2.49	2.80	3.11	3.42	3.73	4.04	4.36	4.67
		κ	.0175	.0200	.0225	.0250	.0275	.0300	.0326	.0350	.0376
19	18.5	p	2.43	2.77	3.13	3.47	3.81	4.17	4.51	4.87	5.22
		κ	.0166	.0190	.0214	.0238	.0262	.0285	.0308	.0333	.0357
18	17.5	p	2.71	3.10	3.50	3.88	4.27	4.65	5.03	5.43	5.83
		κ	.0157	.0180	.0203	.0225	.0248	.0270	.0293	.0317	.0338
17	16.5	p	3.06	3.48	3.93	4.36	4.80	5.23	5.67	6.11	6.55
		κ	.0149	.0170	.0191	.0212	.0234	.0255	.0276	.0298	.0319
16	15.5	p	3.46	3.96	4.43	4.93	5.43	5.91	6.41	6.91	7.40
		κ	.0140	.0160	.0180	.0200	.0220	.0240	.0260	.0280	.0300
15	14.5	p	3.96	4.51	5.07	5.65	6.22	6.79	7.33	7.90	8.48
		κ	.0131	.0150	.0169	.0188	.0206	.0225	.0244	.0262	.0282
14	13.5	p	4.56	5.21	5.99	6.53	7.16	7.89	8.47	9.11	9.75
		κ	.0122	.0140	.0157	.0175	.0192	.0210	.0228	.0245	.0263
13	12.5	p	5.32	6.07	6.83	7.60	8.34	9.10	9.86	10.62	11.35
		κ	.0114	.0130	.0146	.0163	.0179	.0195	.0212	.0228	.0244
12	11.5	p	6.27	7.17	8.10	8.97	9.88	10.76	11.65	12.55	13.42
		κ	.0105	.0120	.0135	.0150	.0165	.0180	.0195	.0210	.0225
11	10.5	p	7.53	8.61	9.66	10.72	11.80	12.85	13.95	15.05	16.10
		κ	.0096	.0110	.0124	.0138	.0151	.0165	.0179	.0193	.0207
10	9.5	p	9.18	10.50	11.80	13.12	14.40	15.60	17.00	18.35	19.70
		κ	.0087	.0100	.0113	.0125	.0138	.0150	.0163	.0175	.0188
9	8.5	p	11.50	13.12	14.75	16.40	18.00	19.70	21.30	23.00	24.56
		κ	.0079	.0090	.0101	.0112	.0124	.0135	.0146	.0157	.0169

Values of $k=\frac{rKb}{sE}$, the last term of eq. (54), are given in Table 12, for a series of values of $\frac{r}{s}$ and Kb, assuming the value of $E=11500000$ for cast iron.

The *width of the ring* has no influence on the spring p or the bending stress. It may vary between

$$b=1\tfrac{1}{4}s \text{ and } 2s, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (55)$$

depending upon the *number of rings* used. The number of rings may be found approximately from

$$s\geq\frac{D}{5b}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (56)$$

in which D = cylinder diameter in inches. It is a matter of experience with gas engines that narrow rings in sufficient number make a tighter packing with less friction than a smaller number of wider rings.

New Books

CONDENSED CATALOGUES OF MECHANICAL EQUIPMENT. Size, 11 by 8½ inches. Pages 708. Numerous illustrations. New York, 1927: American Society of Mechanical Engineers.

The seventeenth annual volume of condensed catalogues is placed at the service of the mechanical engineering profession and gives a closer and more efficient buying relation between manufacturers and users of all classes of mechanical equipment. The information is more up to date than the previous issue and 70 pages have been added to make this issue the largest ever published.

MARINE BORERS AND THEIR RELATION TO MARINE CONSTRUCTION ON THE PACIFIC COAST. By C. L. Hill and C. A. Kofoid. Size, 7¼ by 10½ inches. Pages, 357. Tables, 45. Illustrations, 143. San Francisco, 1927: San Francisco Bay Marine Piling Committee.

In this work has been brought together much information dealing with marine borers and the problem of marine construction where the borer is present. The first part of the book deals with the origin and development of the San Francisco Bay marine piling survey project as well as a history of the marine structures in San Francisco Bay. There are chapters dealing with the geographic and hydrographic aspect of the region and a treatise of the salt water barrier as a proposed remedial measure. Numerous tests have been made on various types of piling as well as various treatments

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of wood piling. These are investigated as an engineering problem and are fully discussed. Chemical investigations have also been made and recorded for reference. Finally, the biological aspect of boring life has been dealt with and a classification of the various types of shipworms, mollusks and crustacean borers has been made. This section is thorough in its treatment and gives a mass of information useful in the preservation of piling and other marine structures.

Oil Engine Power Plant Handbook. Edited by Roswell H. Ward. Size, 10¾ by 7¾ inches. Pages 288. Numerous illustrations, New York, 1927: *Oil Engine Power.*

This is the third edition of a reference book on operation and maintenance of oil engines which covers a wide field and is of interest and use to the oil engine owner and operator.

The work includes a number of questions and answers as a guide to plant routine, followed by a section devoted to oil engine power plant design, construction and operation. The choice and application of Diesel engines are discussed as well as design, construction and operation of plants. Another chapter deals with foundations while the remainder of the book covers many problems met in Diesel operation. Eighty-four pages are added illustrating and briefly describing every American oil engine in active production.

Merchant Vessels of the United States. Pages 976. Washington, 1927: Superintendent of Documents, Government Printing Office.

This book contains the name of every documented merchant vessel and yacht of the United States, approximately 28,500, the tonnage, dimensions, year, and place of building, service, and number of men composing crew, together with the name and address of the owner.

It shows separately the steam, motor, sail, and unrigged merchant vessels and similarly, the yachts. It contains also the name of every documented merchant vessel and yacht which was lost, abandoned, sold to aliens, or removed for other causes during the year. There are lists of oil-burning steamers, vessels measured under Panama and Suez rules, vessels belonging to the Navy, War, Treasury, Commerce, Labor and Interior Departments, the Panama Canal and Panama Railroad Company, and vessels owned in the Philippine Islands.

Personal

John J. Durr, Jr., assistant general freight agent in charge of inward traffic, has been appointed inward freight agent of the **New York and Cuba Mail Steamship Company** (Ward Line), New York city.

J. E. French, who for the last two years has been port superintendent at Houston, Texas, for **Lykes Bros, Ripley Steamship Company,** has been made assistant marine superintendent of the company.

Richard Weglein, director of the **Department of Wharves, Docks and Ferries,** Philadelphia, Pa., has been appointed president of the **Philadelphia Ocean Traffic Bureau,** succeeding **George F. Sproule,** who has retired. **George W. Edmonds** continues as manager of the bureau. All of the officers and members of the executive committee have been reappointed.

Colonel Edward C. Carrington, chairman of the board of the **Hudson River Night Line,** New York, has been appointed president of the corporation, succeeding **John W. McKinnon,** who declined re-election. **Colonel Carrington** is to continue as chairman.

J. E. Gardner, Jr., assistant general agent of the **Robert Dollar Company** at Shanghai, has been elected chairman of the **Associated Steamship Lines** for 1928. He has also been named chairman of the **United States Shipping Board Committee** for 1928.

Captain A. B. Randall, who has been master of the United States liner *Republic* since her reconditioning, has been appointed commander of the steamship *George Washington,* succeeding **Captain Harold A. Cunningham,** who has been made commander of the *Leviathan* and commodore of the fleet.

Obituary

James Wells Barber, former head of the **Barber Steamship Lines, Inc.,** New York, died recently at his home in Englewood, N. J.

George F. Lawley, for 54 years associated with the **George F. Lawley & Son Corporation,** Neponset, Mass., died on March 21 at the age of 80.

Captain Frank W. Armstrong, secretary of the **Marine Society of the City of New York,** died on Thursday, February 16, in the New York Hospital.

Captain Willis Edmund Chilson, superintendent of the **Pickands, Mather and Company,** Cleveland, owners of the **Interlake Steamship Company,** died recently in Buffalo, N. Y.

Walter S. Smith, assistant manager of the **Maritime Exchange,** died recently at his home, 530 Audubon Avenue, Manhattan, New York, after a brief illness. Mr. Smith had been connected with the Maritime Exchange for the past 32 years.

Captain Edmund Kemble, retired naval officer, who had resided in Mount Vernon for 25 years, died at his home, 115 East Lincoln Avenue, recently. Captain Kemble served in all a total of 70 years on the sea, until he retired five years ago. Prior to his retirement he was commodore of the Clyde Steamship Lines, New York. He was 91 years of age.

John A. Francombe, pioneer vessel owner on the Great Lakes, died recently in Detroit, Mich., at the age of 80. His first connection with the shipping business was as manager and part owner of the **Bay City and Cleveland Navigation Company.** In later years he was manager and part owner of the **Hope Transportation Company.** In 1912 he became associated with **John Bietz,** the late Benjamin Noble and the late Alex Ruelle in the operation of the **Capitol Transportation Company,** retiring to private life in 1914.

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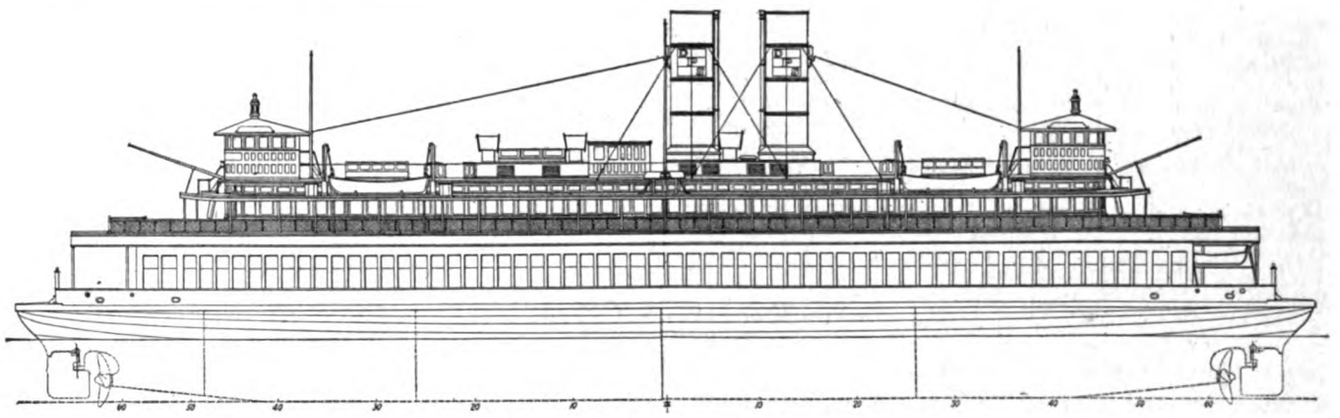
Ship Construction and Repair News

Proposed work—Bids asked—Bids received—Contracts awarded—Current activities



Proposed ferryboat except for slight changes will be similar to American Legion

Specifications Covering Construction of Ferryboat for New York City

TENDERS were received by Albert Goldman, commissioner of the Department of Plant and Structures, New York, on March 27, for the construction of one ferryboat. The new ferryboat design is similar in many respects to the *American Legion* now operated by New York City except that the length will be increased 3 feet and the new vessel will have guard braces instead of the steel sponsons as used on the former boat.

The new ferryboat is to have a length of 267 feet; breadth over guards 66 feet; molded breadth 46 feet; molded depth about 19 feet 9 inches, and draft in operating condition 12 feet 6 inches. Her arrangement will be similar to the *American Legion,* having two driveways, steel hull, two decks and the lower cabins will be built and sheathed with steel.

The propelling machinery will consist of two vertical compound steam engines coupled together and driving a through shaft, with a propeller at each end. The engine cylinders will be 22½ inches and 50 inches diameter with a 30-inch stroke, designed for about 4,000 indicated horsepower. Four watertube boilers with a heating surface of about 3,575 square feet each will have a working pressure of 225 pounds per square inch.

Pulverized Coal Equipment Ordered

THE Peabody Engineering Corporation, New York, has received an order for powdered coal burners and other equipment to be installed by the Halifax Shipyards, Ltd., Halifax, N. S., on the Dominion Coal Company's steamship *Lingan.* The work is being carried on under the direction of the owners' naval architect, E. C. Bennett of New York. Kennedy pulverizers will be used.

Matson Navigation Company Is Planning 3 Liners for Australian Service

IT has been learned that the Matson Navigation Company, 215 Market street, San Francisco, California, is contemplating the construction of three new passenger liners to cost about $5,000,000 each, for the run between San Francisco and Sydney. The new ships are to have accommodations for 350 first class, 250 second class and 7,000 tons of freight. Additional details will be available at a later date.

Contract for Three Lightships Awarded to West Coast Yard

A CONTRACT for the construction of three electric lightships has been awarded to the Albina Marine Iron Works, Portland, Oregon, by the United States Lighthouse Service, Washington, D. C., at a price of $552,616. Bids for the work were received at Washington on October 15, last. One of the ships will be stationed off San Francisco harbor to replace the one on duty there for the last 30 years.

The general dimensions of the new vessels are: Length overall 133 feet 3 inches; length on waterline 108 feet 9 inches; beam 30 feet; depth at side, molded, 15 feet; draft 11 feet 9 inches forward, 13 feet 3 inches aft; displacement 630 tons and shaft horsepower 350. The hull and superstructure are to be built entirely of steel having complete fore and aft main and upper decks with two deck houses. The forward deck house comprises the pilot house and the master's quarters; the after deck house contains the radio room and the operator's quarters.

The propelling machinery consists of a direct connected double armature motor delivering 350 shaft horsepower to a single screw propeller.

Shipping Board to Ask Bids for Converting 8 Ships to Diesel Drive About May 1

INFORMATION has been received that Captain R. D. Gatewood, manager of the maintenance and repair division of the United States Shipping Board, 45 Broadway, New York, is now having plans and specifications drawn up for the conversion of 8 Shipping Board vessels to Diesel drive and that these specifications will be issued to shipyards for bids about May 1.

For this second part of the Diesel conversion program it is understood that bids will be asked on 2, 4, 6 and 8 ships and that all contracts will be made on this basis at one time. Further information will be available as plans develop.

Ericsson Line to Ask Bids for Construction of Passenger and Freight Steamboat

IT IS believed that the Baltimore and Philadelphia Steamboat Company (Ericsson Line), Philadelphia, Pa., will shortly issue plans and specifications for the construction of a passenger and freight steamboat, which will closely follow the design of the most recent vessel added to the fleet, the *John Cadwalader.* This steamer was built by the Pusey and Jones Company, Wilmington, Del., in 1926.

Details of this ship are: Length overall 230 feet; length between perpendiculars 219.7 feet; beam over guards 45 feet; molded beam 43.6 feet; molded depth 14.8 feet. The machinery consists of a 4-cylinder triple expansion engine, having cylinder diameters of 21 inches, 32 inches, 35 inches, 35 inches and a stroke of 24 inches, developing 2,000 shaft horsepower. Steam is supplied by 2 watertube boilers at a working pressure of 210 pounds per square inch. These boilers are equipped to burn oil fuel.

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Sun Shipyard Going Ahead with Construction of 20,000-ton Tanker

IT IS understood that work is now definitely going forward at the Sun Shipbuilding and Drydock Company, Chester, Pa., for the construction of an oil tanker of about 20,000 tons displacement and about 15,000 tons deadweight carrying capacity, to the order of the Sun Oil Company, Philadelphia, Pa.

A special feature of this vessel will be the installation of mercury type boilers, developed by W. L. R. Emmet, consulting engineer of the General Electric Company, Schenectady, New York. It will be the first installation of steam generating equipment of the kind aboard ship.

The tanker will be driven by a single screw at a speed of about 11 knots. The main propelling machinery will probably consist of geared turbines, developing between 2,500 to 3,000 shaft horsepower.

Three Types of Drive to be Considered for the Mount Vernon and Monticello

IT has been learned that the United States Shipping Board has authorized Gibbs Brothers, Inc., naval architects, New York, to proceed with the taking of bids for reconditioning the steamships *Mount Vernon* and *Monticello* immediately after the committee on appropriations has acted on the bill now pending in Washington. The authorization for bids, as given to the naval architect, includes propositions for the two vessels on the basis of geared turbine drive, turbo-electric drive and direct-connected Diesel drive.

It is further understood that the appropriation bill for the work, as approved by the Senate, stipulated that $10,000,000 of the amount be provided from the construction loan fund of the Shipping Board and that the Shipping Board from its own funds make up whatever additional amount is necessary to carry the work to completion. It is believed that definite action on the matter will be taken within the next few days.

Hudson River Night Line Asks Shipping Board for Loan to Build 2 Ships

INFORMATION has been received from C. K. Crosby, general manager of the Hudson River Navigation Company (Hudson Night Line), Pier 32, North River, New York, that his company is at present negotiating with the United States Shipping Board for a loan from the construction loan fund to help finance the construction of 2 Diesel ships for Hudson River service. Plans and specifications were prepared by the firm of Henry J. Gielow, Inc., naval architects,, New York, and bids were taken some weeks ago. As soon as the matter has been settled in Washington, it is believed that a contract will be placed immediately for the construction of these vessels.

The boats are to have a length of about 300 feet; beam of 50 feet over the guards; depth of hull 16 feet and a speed of 16 knots. They are specially designed for automobile carrying service in the New York-Troy-Albany run.

Specifications for Converting Six Ships to Pulverized Coal Burners to be Issued Soon

PLANS and specifications for the installation of pulverized coal-burning equipment on 6 Shipping Board vessels have been practically completed and they will be issued by Captain R. D. Gatewood, manager of the maintenance and repair division of the United States Shipping Board, 45 Broadway, New York, immediately upon authorization of the Shipping Board. It is expected that this authorization will be forthcoming within the next two weeks.

So far, only two ships have been surveyed for the work, these being the steamship *West Alsek* and steamship *West Apaum*. It is not yet known which 4 vessels will be included in addition to these to complete the program.

S.S. Robert E. Lee May Be Reconditioned

INFORMATION has been received that the firm of Merritt-Chapman and Scott Corporation, New York, has been called into consultation by the Eastern Steamship Lines, Inc., Boston, Mass., for the removal of the steamship *Robert E. Lee*, which went aground on Mary Ann Rocks, off Manomet Point on Friday, March 9, while on her way from Boston to New York. The possibility of removing the steamer is being investigated at the present time and a contract will be awarded for the work within a few days if it is found practicable.

With the exception of the hole ripped in the bottom of the vessel and damage resulting from flooding the ship, it is believed that the hull itself is in a salvageable state, in which case she will be patched up and taken to drydock for survey and repairs.

Bids Asked for Installation of Towboat John C. Irwin Engine

THE United States Engineer Office, Customhouse, Nashville, Tenn., is now receiving informal proposals for new machinery for the towboat *John C. Irwin*. No formal date for closing reception of these bids has as yet been set. Bids were originally received on January 9, 1928, but these were rejected.

Under these informal bids, the United States Engineer Office proposes to award a contract for only installation of the new machinery, the Government to furnish the new engine for installation, without cost to the contractor. It is not known as yet when final award will be made, but it is expected that it will be within the next 30 days.

Bids for Six Thrust Blocks

THE United States Shipping Board recently sent out invitations for tenders on 6 thrust blocks. The bids covering the equipment were opened on March 26 in the office of Captain R. D. Gatewood, manager of the maintenance and repair division of the Board, 45 Broadway, New York City. This equipment will be used in connection with the conversion of 8 vessels to Diesel drive.

Lake Washington Shipyard to Rebuild S.S. Iroquois

CONTRACT for converting the steamship *Iroquois* of the Puget Sound Navigation Company, Seattle, Wash., into a ferryboat for operation between Seattle and Victoria, B. C., has been awarded to the Lake Washington Shipyards at Seattle, Wash. The work is to be completed by July 1, 1928. Four other tenders were received as follows: Commercial Boiler Works, Lake Union Drydock and Machine Works, and Todd Drydock, Inc., all of Seattle, and Williamette Iron and Steel Works, Portland, Oregon.

The vessel is to be entirely rebuilt, according to plans prepared by Lee and Brinton, Seattle naval architects. The deck will be raised, new staterooms built, the ship widened from 36 to 48 feet and new boilers and machinery installed. The price involved was not made public.

Wallace Company to Build Steel Cable Barge

THE Wallace Bridge and Structural Steel Company, Seattle, Wash., was recently awarded the contract for the construction of a steel cable barge for the Pacific Telephone and Telegraph Company of San Francisco, Calif. Approximately $80,000 is involved.

An additional contract calling for the construction of two steel barges was also received by the Wallace Company recently, for the Kamschatka Corporation, soviet company, which controls Eastern Siberian and Kamschatka development.

U. S. Engineers Ask Bids on Two Dredging Pumps

TENDERS were received by the United States Engineer Office, Trust Company building, Galveston, Texas, until 2:30 P. M., March 12, 1928, and then opened, for furnishing two 22-inch dredging pumps, one port and one starboard pump, complete with impeller shafts, nuts, liners, suction nozzles, glands, neck bushings, bolts and studs. Award will be made as a whole at a later date.

Yacht Aloha Being Repaired

WORK is now under way at Newport, R. I., on repairs to the yacht *Aloha*, owned by Commodore James of the New York Yacht Club. The work includes the stiffening of deck erections and other alterations at a cost of about $20,000. Mr. Barton B. Cook, of the staff of Theodore E. Ferris, naval architect, New York, is supervising the repairs and alterations.

Riter-Conley Co. Awarded Contract for Six Barges

A CONTRACT for the construction of six steel barges has been awarded to the Riter-Conley Company, Pittsburgh, Pa., by the Barrett Line, Inc., Cincinnati, Ohio. The barges are to be 235 feet by 40 feet by 10 feet, and of 2,000 tons capacity each. The price involved was not given out.

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Construction and Repair Bids

Bids for Two Panama Steamship Company Ships Opened on March 24

THE date for the receipt of bids for the construction of two passenger steamships for the Panama Steamship Company, New York, was changed from March 17 to March 24, 1928, when the proposals were opened. The firm of Cox and Stevens, naval architects, New York, prepared the designs and all details in connection with the proposed ships. The tenders were opened at the offices of the naval architects at 341 Madison Avenue, New York city.

Plans for Construction of High Powered Steam Yacht Issued And Bids Received

PLANS and specifications were recently issued by the firm of Henry J. Gielow, Inc., 25 West 43rd street, New York City, covering the construction of a geared turbine drive steam yacht, which, if built, will be one of the largest and probably the most powerful private yacht affoat. Bids were asked from a number of shipyards including: Bethlehem Shipbuilding Corporation, Ltd., Bethlehem, Pa.; Newport News Shipbuilding and Drydock Company, Newport News, Va.; Federal Shipbuilding Company, Kearny, N. J.; American Brown Boveri Electric Corporation (New York Shipbuilding Corporation), Camden, N. J.; Bath Iron Works Corporation, Bath, Me.; and Pusey and Jones Corporation, Wilmington, Del. These bids were opened March 20.

The yacht will have a length overall 310 feet; a length between perpendiculars 308 feet; a beam of 44 feet, and a draft of 18 feet. The propelling machinery will develop 15,000 shaft horsepower, giving the yacht a speed of about 28 knots. It is understood that machinery will operate under a steam pressure of 350 pounds per square inch with 250 degrees of superheat. Further details will be available later.

Charleston Drydock Company Submits Low Bid for Diesel-Electric Ferryboat

THE Charleston Drydock and Machine Company, Charleston, S. C., submitted the lowest bid of $174,000 on Saturday, March 10, covering the construction of one new steel Diesel-electric ferryboat for the Norfolk County Ferries, Portsmouth, Va. Bids from 10 other shipyards on the Atlantic Coast were received and include: Pusey and Jones Corporation, Wilmington, Del.; Todd Shipyards Corporation, New York; Spear Engineers, Inc., Norfolk, Va.; Spedden Shipbuilding Company, Baltimore, Md.; Sun Shipbuilding and Drydock Company, Chester, Pa.; Staten Island Shipbuilding Company, Staten Island, N. Y.; American Brown Boveri Electric Corporation, Camden, N. J.; Baltimore plant of the Bethlehem Shipbuilding Corporation, Ltd., Baltimore, Md.; Newport News Shipbuilding and Drydock Company, Newport News, Va., and New London Ship and Engine Company, Groton, Conn. Prices ranged from the lowest bid of $174,000 to $245,000.

Plans and specifications for the work were prepared by Eads Johnson, 115 Broadway, New York. The new vessel will have a length overall 173 feet; length between perpendiculars 146 feet; beam overall 57 feet; beam of hull at deck 37 feet; depth, molded, 14 feet, and draft 8 feet 6 inches.

The propelling machinery consists of 2 full Diesel engines of 400 brake horsepower each, direct connected to 2 generators of 270 kilowatts each, 2 exciters of 30 kilowatts each and one double armature propelling motor of 650 horsepower on through shafting with propeller at each end. Three manufacturing concerns, the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.; General Electric Company, Schenectady, New York, and the Electro-Dynamic Company, New York City, submitted tenders on March 3 for the construction of the electric-propulsion equipment.

The results of the bids have been submitted to the Norfolk County Commissioners for authorization and if a decision is reached, it is expected that contracts for the construction of the hull and machinery will be awarded shortly.

Shipping Board Receives Bids for 66 Pumps

BIDS were asked by the United States Shipping Board Merchant Fleet Corporation for furnishing all or any part of 66 pump equipments, and 14 additional motors, and these were opened at noon, March 28, 1928, at the office of Captain R. D. Gatewood, manager of the maintenance and repair division of the Board, 45 Broadway, New York City.

The type of pumps required and their service is given in the following table:

No. Req.	Service	Cap. U. S. gals. per Minute	Motor H. P.
16	Salt Water Cooling and General Service	1,100	60
2	Fresh Water Piston Cooling	300	20
8	Bilge	300	7½
6	Fire	200	20
4	Salt Water San'y	120	7½
8	Potable Water	30	1½
4	Fresh Water San'y	30	1½
4	Lubricating Oil and Piston Cooling	800	60
12	Lubricating Oil	175	7½
2	Fuel Oil Transfer	150	7½

The motors will operate at 1,750 revolutions per minute. The Shipping Board power at prices quoted.

Hoist Proposals

SEALED proposals were received by the Mississippi River Commission, First and Second Districts, 1006 McCall building, Memphis, Tenn., until 11:00 A. M., March 21, 1928, and then opened, for furnishing and delivering two 3-drum hoists and two 2-drum hoists.

Bids for Six Emergency Air Compressor Units Opened

PROPOSALS were received and opened at the office of Captain R. D. Gatewood, manager of the maintenance and repair division of the United States Shipping Board Merchant Fleet Corporation, 45 Broadway, New York, Wednesday, March 14, 1928, for furnishing all or any part of 6 port and emergency air compressor units for the 8 vessels selected for conversion to Diesel drive in the second stage of the conversion program. Three tenders were received as follows:

Cummins Engine Company, Columbus, Ind., four-cylinder, 5¾ by 8½ inches, 625 revolutions per minute, 30-kilowatt generator, Winton model, 118 compressor, $6,445 each.

Fairbanks, Morse and Company, Beloit, Wis., four-cylinder, 6 by 6½ inches, 725 revolutions per minute, 30-kilowatt generator, Winton model, 118 compressor, $7,626 each; with Norwalk type V. A. compressor, $8,111 each; with Rix No. 1 type X. H. compressor, $7,021 each.

Hill Diesel Engine Company, Lansing, Mich., four-cylinder 6 by 10 inches, 4-cycle Hill Diesel engine, 600 revolutions per minute, 30-kilowatt electro-dynamic generator, Winton model, 118 compressor, $8,734 each.

Captain R. D. Gatewood has made recommendations to the Shipping Board concerning the award of contracts.

Bids for Three U. S. Engineer Barges

THE date for the receipt of bids for the construction of three new steel barges for the United States Engineer Office, Huntington, W. Va., was set for March 30, 1928. At the time of going to press no change in the date had been made.

One barge is to be 80 feet long, 18 feet wide, 4½ feet molded depth at gunwale, decked with 2½-inch camber and 4 feet transverse trussed frames.

Two barges are to be 80 feet long, 26 feet wide and 5 feet molded depth at gunwale. Delivery is to be made to the United States Engineers at Marietta, Ohio, all expense and risk of such delivery to be borne by the contractor.

Plans and specifications are now on exhibition at the following addresses, where they may be inspected: United States Engineer Office, Huntington, W. Va.; Pittsburgh, Pa.; Charleston, W. Va.; Marietta, Ohio; Louisville, Ky.; and office of the Division Engineer, Central Division, Room 413 Customhouse, Cincinnati, Ohio.

Robins Drydock Co. to Repair S.S. El Almirante

THE Southern Pacific Steamship Lines, New York, has awarded a contract to the Robins Drydock and Repair Company, Brooklyn, New York, covering repairs to the 5,216-gross ton steamship *El Almirante*, at a price of $23,819. Bids for the work were received in New York recently, and five other tenders were submitted as follows:

Name	Price
New York Harbor Drydock Company, Inc.	$26,020
Tietjen and Lang Drydock Company	26,377
W. and A. Fletcher Company	26,800
Morse Drydock and Repair Company	31,792
James Shewan and Sons, Inc.	33,994

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Bids for 39 Barges Received

PROPOSALS were received and opened at the office of the Mississippi River Commission, First and Second Districts, Memphis, Tenn., on March 3, 1928, for the construction and delivery, f.o.b. bidder's shipyard, of 41 steel barges, with the following results.

Name	Unit Price	Total 39 Barges	Delivery Barges	Delivery Days
Dravo Contracting Company, Pittsburgh, Pa.	$10,335	$403,065	5	95
			10	@ 3-day intervals
			24	@ 2-day intervals
			(2 extra—177)	
American Bridge Company, Pittsburgh, Pa.	10,440	407,160	1	45
			10	75
			10	105
			10	135
			8	159
			(2 extra—165)	
Riter - Conley Company, Pittsburgh, Pa.	10,457	407,823	1	75
			38	282
			(2 extra—288)	
Nashville Bridge Company, Nashville, Tenn.	10,920	425,880	10	190
			10	250
			10	320
			9	370
			(2 extra—384)	
Alabama Drydock and Shipbuilding Company, Mobile, Ala.	10,990	428,610	1	100
			(1 every 5 days thereafter)	
Jones and Laughlin Steel Corporation, Pittsburgh, Pa.	11,427	445,653	10	165
			10	230
			10	295
			9	350
			(2 extra—365)	
Midland Barge Company, Midland, Pa.	11,500	448,500	9	230
			10	275
			10	320
			10	365
Chicago Bridge and Iron Company, Chicago, Ill.	12,350	481,650	9	141
			10	200
			10	230
			10	290
			(2 extra—302)	
Howard Shipyards and Dock Company, Jeffersonville, Ind.	13,197	514,683	10	240
			15	340
			10	440
			4	475
			(2 extra—490)	
Marietta Manufacturing Company, Point Pleasant, W. Va.	15,128	589,992	10	160
			10	230
			10	300
			9	363
			(2 extra—367)	
J. S. Schofield and Sons, Macon, Ga.	21,436	836,004	10	335
			10	525
			10	715
			9	895
			(2 extra—925)	

A contract for the work has been awarded to the American Bridge Company, Pittsburgh, Pa.

S.S. Padnsay to be Repaired at Robins Drydock

THE Robins Drydock and Repair Company, Brooklyn, New York, has been awarded the contract covering repairs to the Shipping Board steamship *Padnsay*, at a price of $14,261, bids for which were recently received in New York. Six other tenders were submitted as follows:

Name	Price
Morse Drydock and Repair Company	$14,843
New York Harbor Drydock Company, Inc.	15,204
Theodore A. Crane's Sons Company	17,190
Federal Shipbuilding Company	17,217
James Shewan and Sons, Inc.	18,128
Staten Island Shipbuilding Company	18,714

Brewer Drydock Co. to Repair S.S. Charles R. Norman

A CONTRACT for repairs to the steamship *Charles R. Norman* has been awarded to the Brewer Drydock Company, Mariners Harbor, New York, by the East Jersey Railroad and Terminal Company, 11 Broadway, New York, at a price of $7,487 and a time of 28 days. Bids for the work were received in New York on Tuesday, March 13. Other bids were as follows:

Name	Price	Days
W. and A. Fletcher Company	$ 8,300	27
Staten Island Shipbuilding Company	8,818	32
Russell and Company	9,389	40
Todd Shipyards Corporation	10,540	40
Caddell	10,873	24
Robins Drydock and Repair Company	12,890	25
Tietjen and Lang Drydock Company	13,840	46

Bids Received for Two Mooring Barges

WITH a price of $25,800 for one barge and $51,600 for two barges, the Dubuque Boat and Boiler Works, Dubuque, Iowa, submitted the lowest tender for the construction of two steel hull mooring barges, bids for which were received by the Third Mississippi River District, Box 404, Vicksburg, Miss. The barges are to be delivered at Vicksburg. Other proposals received for the work were:

Name	Price 1 Barge	Price 2 Barges
Nashville Bridge Company, Nashville, Tenn.	$26,430	$52,860
St. Louis Structural Steel Company, East St. Louis, Ill.	26,885	53,770
Midland Barge Company, Midland, Pa.	27,000	54,000
Dravo Contracting Company, Pittsburgh, Pa.	27,985	55,970
Riter Conley Company, Pittsburgh, Pa.	28,400	56,800
Marietta Manufacturing Company, Point Pleasant, West Virginia	29,768	59,536
Charles Hegewald Company, New Albany, Ind.	30,990	61,980
J. S. Schofield's Sons Company, Macon, Ga.	42,396	84,792

Bids for S.S. San Lorenzo Repairs Opened

BIDS were received by Frank S. Martin and Son, naval architects, 25 Broadway, New York, recently, covering repairs to the steamship *San Lorenzo*, owned and operated by the New York and Porto Rico Steamship Company, New York City, with the following results:

Name	Price	Time CRD	Casting Time (Days)
Robins Drydock and Repair Company	$10,290	8	45
W. and A. Fletcher Company	10,429	9	8 weeks
Morse Drydock and Repair Company	10,638	12	10 weeks
New York Harbor Drydock Company, Inc.	10,947	48	.....
Atlantic Basin Iron Works Corporation	11,350	12	75
Tietjen and Lang Drydock Company	11,850	10	8 weeks
Staten Island Shipbuilding Company	13,400	12	12 weeks

The award has not as yet been made.

W. and A. Fletcher Company Bid Low on M.S. Tampa

WITH a price of $7,117, the W. and A. Fletcher Company, Hoboken, N. J., submitted the lowest proposal covering repairs to the Shipping Board motorship *Tampa*. Tenders for the work were received in New York on Wednesday, March 14, 1928, and four other bids were submitted as follows:

Name	Price
Morse Drydock and Repair Company	$ 8,071
Robins Drydock and Repair Company	8,432
James Shewan and Sons, Inc.	8,746
New York Harbor Drydock Company, Inc.	11,500

Repair Bids Taken on S.S. American Legion and S.S. Southern Cross

TENDERS were received in New York by the Munson Steamship Line, 67 Wall street, recently, covering repairs to the steamship *American Legion* and steamship *Southern Cross*, with the following results:

Name	Price A	Price B
Tietjen and Lang Drydock Company	$27,600	$26,200
Robins Drydock and Repair Company	28,750	26,800
Morse Drydock and Repair Company	21,530	52,000

The award has not as yet been made.

Bids were also received at the same time covering repairs to the steamships *Pan America* and *Western World*. The following bids were submitted:

Name	Price A	Price B
Tietjen and Lang Drydock Company	$23,500	$33,600
Robins Drydock and Repair Company	25,200	36,200
Morse Drydock and Repair Company	23,317	55,490

The award has not as yet been made.

Barge Paul Howard to be Repaired by Robins Drydock Co.

A CONTRACT covering repairs to the Thomas J. Howard barge *Paul Howard* has been awarded to the Robins Drydock and Repair Company, Brooklyn, New York, at a price of $9,765 and a time of 21 continuous running days. Bids for the work were received in New York recently and other proposals submitted were:

Name	Price	Continuous Running Days
Morse Drydock and Repair Company	$10,599	25
Ira S. Bushey and Sons, Inc.	16,476	18
Perth Amboy Drydock Company	16,300	21
Theodore A. Crane's Sons Company	17,223	20
Staten Island Shipbuilding Company	17,954	23
Brewer Drydock Company	17,986	24

Robins Drydock Gets S.S. Connehatta Contract

A CONTRACT covering repairs to the United States Shipping Board steamship *Connehatta* has been awarded to the Robins Drydock and Repair Company, Brooklyn, New York, at a price of $7,319. Five other bids were received as follows:

Name	Price
W. and A. Fletcher Company	$7,970
Morse Drydock and Repair Company	8,094
New York Harbor Drydock Company, Inc.	8,500
Staten Island Shipbuilding Company	9,525
Theodore A. Crane's Sons Company	11,029

The work is to be completed at 5:00 P. M., March 7, 1928.

Bids for Four Shipping Board Tankers Received

THE United States Shipping Board has received a joint bid from the American-Hawaiian and Matson Lines for the purchase of four tankers now being operated between San Francisco and the Orient. The vessels are the *Neton, Dilworth, Stockton* and *Salina*, each of 10,500 tons deadweight.

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I.M.M. Plans Three More Liners for Intercoastal Service

IT HAS been learned that P. A. S. Franklin, president of the International Mercantile Marine Company, New York, has announced that the Panama Pacific Line, a subsidiary of the International Mercantile, plans three more liners for the intercoastal trade, in addition to the *California* and its two sister ships already contracted for.

A fleet of six liners of the *California's* type would place the company in a dominant position in the trade and would enable them to maintain weekly sailing from New York to San Francisco. The *California* cost a little more than $6,000,000 to build and the fleet of six liners would represent an outlay of more than $36,000,000.

The *California,* the first commercial liner in the world to be propelled by turbo-electric drive, was recently completed at the yards of the Newport News Shipbuilding and Drydock Company, Newport News, Va., and sailed from New York on January 28 on her maiden voyage for San Francisco.

Work is now progressing rapidly on the construction of the *Virginia,* sister ship of the *California,* in the Newport News yard, and it is expected that this vessel will be launched some time next year, following which the keel of the third ship, in the first building program of three liners, will be laid. Like the *California,* the *Virginia* and the third liner yet to be named, will be propelled by turbo-electric drive.

Export Steamship Corp. to Construct Vessels for Mediterranean Service

IT IS reported that Henry Herbermann, president of the Export Steamship Corporation 25 Broadway, New York, in a testimony before the House of Representatives Committee on a Merchant Marine and Fisheries stated definitely that his company planned to undertake the construction of one or more ships for Mediterranean service and that construction would commence within the next few months.

In a previous statement to the Shipping Board, Mr. Herbermann stated that the Export Steamship Corporation would build three 18-knot passenger and cargo vessels for the New York-Mediterranean trade provided that long term mail carrying contracts could be made with the government and that a loan could be obtained from the construction loan fund of the United States Shipping Board.

The present statement indicates that the company will undertake the work in any event, but it is believed that Mr. Herbermann is now in Washington to bring the matter to a definite termination.

Completely Welded Tank Barge Under Construction

A COMPLETELY welded steel tank barge is being constructed at the yard of the S. O. S. Welding Corporation of Brooklyn, New York, under the direction of Captain Hawkins, the owners' representative. It is understood that this barge has been ordered by a Canadian concern and will class A. 1 E., according to the requirements of the American Bureau of Shipping.

The barge will have a length overall of 102 feet; breadth of 20 feet; depth of 8 feet, and a designed draft of 6 feet 6 inches. Its designed capacity is 75,000 gallons of gasoline and 4,500 gallons of Diesel fuel in bunkers. A 125-horsepower Atlas Imperial Diesel engine will operate a 50-inch diameter and 34-inch pitch Columbian propeller. The vessel will operate with a crew of 3 and accommodations for 6 will be available.

Todd Shipyards to Repair S.S. Chickasaw

WITH a price of $9,330, the Todd Shipyards Corporation, New York, was successful bidder for repairs to the United States Shipping Board steamship *Chickasaw.* Bids for the work were received at New York recently and seven other tenders were submitted as follows:

Name	Price
W. and A. Fletcher Company	$10,300
Morse Drydock and Repair Company	11,979
Atlantic Basin Iron Works Corporation	12,639
New York Harbor Drydock Company, Inc.	12,950
Sun Shipbuilding and Drydock Company	14,618
Staten Island Shipbuilding Company	15,463
Bethlehem Shipbuilding Corporation, Ltd.	16,500

The work is to be completed five days after delivery of the vessel to the successful contractor.

Kensington Plant Reopens

THE Kensington ship repair plant of the William Cramp and Sons Ship and Engine Building Company, Philadelphia, Pa., recently purchased by Francis J. McDonald for $1,250,000, was reopened recently. It will be operated under the name of the Kensington Shipyard and Drydock Company, of which Mr. McDonald is president.

The plant has a drydock 432 feet long, with a breadth of 70 feet at the entrance. In addition there are two marine railways, one 600 feet long and the other 540 feet long. The plant has been pronounced the most completely equipped yard in the country.

Steamer Cadillac Launched

THE steamer *Cadillac,* last vessel on the expansion program of the Detroit and Windsor Ferry Company, Detroit, Mich., was recently launched at the Wyandotte, Mich., yards of the Great Lakes Engineering Company.

The vessel, which has a length of 214 feet overall with accommodations for 2,500 passengers and 75 automobiles, will be delivered to the owners about April 25 and placed in service during the summer season between Detroit and Windsor, Ont., Canada.

Diesel-Electric Harbor Freight Boat Commissioned

THE new steel Diesel-electric freight boat *Edward F. Farrington,* built for the Middlesex Transportation Company, New Brunswick, N. J., was recently placed in service in New York harbor. The boat was built by the Fore River (Quincy, Mass.) plant of the Bethlehem Shipbuilding Corporation from designs prepared by Eads Johnson, naval architect, New York.

The *Farrington* which is of steel construction throughout, has a length overall of 130 feet; length at waterline, 120 feet; beam, 30 feet; depth, 12 feet; capacity, 100 tons of freight at 7 feet 6 inches mean draft.

The machinery, controlled entirely from the pilot house, consists of two 250 brake horsepower Winton Diesel engines, direct connected to two 165-kilowatt generators and two 15-kilowatt exciters. The propelling motor is of the double armature type developing 400 shaft horsepower and is controlled by the Ward-Leonard system from the pilot house. All electrical equipment was supplied by the General Electric Company.

Status of Ship Work in Great Lakes Yards

THE present season shows a dearth of new ship construction in Great Lakes shipyards. For the first time in several years, no bulk cargo carriers are on the ways in any of the yards, while ship repair and conditioning work is at about the average level. This function is an important one and each of the yards has its fair proportion of the work of keeping the ships of the Great Lakes fleets in condition. A resumé of the status of work in each of the more important yards follows:

The Toledo Shipbuilding Company, Inc., Toledo, Ohio, has no new construction in progress, but has a fair amount of repair work including both hull and machinery.

The American Shipbuilding Company, Lorain, Ohio, yard is completing a tanker for the Standard Oil Company of Indiana, and a Diesel drive tanker for the Roxana Petroleum Corporation. Both vessels are for service on the Great Lakes. Under repair and conditioning work, the largest job now under way at the yards of this company is that of the steamship *Hoover and Mason,* a self unloader for G. A. Tomlinson, Cleveland, O.

The Great Lakes Engineering Works, River Rouge, Mich., is completing the passenger and automobile steamer *Cadillac,* for the Detroit and Windsor Ferry Company, as well as a ferryboat for the state of Michigan to be operated across the straits of Mackinac. In addition to this work, the yard is building two fair sized ships and a number of large scows and barges.

At the Manitowoc Shipbuilding Corporation, Manitowoc, Wis., a number of barges are under construction for the U. S. Engineers and several private concerns; two dump scows for the Great Lakes Dredge and Dock Company; one small tug boat and one large Diesel tug boat. The conversion of a freighter to a sand suction ship is also in process of completion for the Great Lakes Dredge and Dock Company at a cost of about $500,000.

Launchings

THE harbor tanker *J. Norman Riley* was launched at the plant of Jakobson and Peterson, Inc., Brooklyn, New York, recently, for the firm of Reilly and Kendall of 11 Broadway, New York. The tanker, which was especially built for harbor work, will have a carrying capacity for 100,000 gallons of oil. It is 128 feet long, with a beam of 28½ feet and a depth of 7½ feet, and is propelled by two Fairbanks-Morse C. O. engines of 180 horsepower each.

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The passenger steamship *Yorktown*, being constructed for the Chesapeake Steamship Company, of Baltimore City, Baltimore, Md., was launched at the plant of the Newport News Shipbuilding and Drydock Company, Newport News, Va., a short time ago. The steamer will be operated between Baltimore and West Point, Va. She has accommodations for 360 passengers.

New Incorporation

WITH a capitalization of $500,000, the Tacoma Oriental Steamship Company, which has been organized to operate the American Oriental Mail Line, purchased recently from the United States Shipping Board by Tacoma interests, has been incorporated under the laws of Nevada. J. F. Hickey of Tacoma, has been appointed temporary president. Samuel S. Jackson and George P. Wright have been named as members of the executive committee.

TRADE PUBLICATIONS

DIESEL ENGINES.—The Worthington Pump and Machinery Corporation of New York has published bulletin No. S-173 describing the Worthington double acting two cycle Diesel engine.

DIESEL YACHT CRESSIDA.—A booklet has been distributed by Cox and Stevens, New York giving a complete description of the seagoing auxiliary Diesel yacht *Cressida* for Hermann Oelrichs.

ELECTRIC GALLEY EQUIPMENT.—The Edison Electric Appliance Company, Inc., Chicago, Ill., has issued three new price lists, form H741, H741D and H741J covering electric bakery, hotel and restaurant equipment.

ELECTRIC HOISTS.—The Chisholm-Moore Manufacturing Company has issued bulletin No. 31, covering the various types of hoists made by the company and giving diagrams and tables of clearances, dimensions and other data.

ARC WELDER.—The Fusion Welding Corporation of Chicago, Ill., has published a bulletin giving a general description of "Fuzon" flexible arc welders. The outfit incorporates the one-control feature; no exciter, external stabilizer or rheostat is necessary.

HASKELITE.—A copy of "The Lightweight Champions Record" has recently been received from the Haskelite Manufacturing Company, Chicago, Ill., makers of Haskelite and Plymetl. In the columns of this house organ the Diesel yacht *Savarona* is described in which Haskelite was used throughout all the living quarters.

GAS CUTTING.—A pamphlet issued by the Air Reduction Sales Company of New York, entitled "Factors Involved in Economical Gas Cutting," by J. L. Anderson has been received. While the author did not undertake to give a complete analysis of all the factors involved in cutting, he has covered those of most importance to the average user of the cutting process.

M. S. DRONNING ALEXANDRINE.—Burmeister and Wain, Ltd., of Copenhagen, Denmark, has issued a catalogue devoted to a complete description of the M. S. *Dronning Alexandrine*, a vessel for the Copenhagen-Iceland Service.

SEADROME SYSTEM.—A booklet has been received describing a proposed seadrome system to be used in connection with E. R. Armstrong's project for commercial ocean transit by airplane.

WINCHES AND CAPSTANS.—Bulletin No. 27 of the Silent Hoist Winch and Crane Company, Brooklyn, N. Y., has been issued describing vertical and horizontal capstan winches, single and double drum winches and self-contained units complete with electric motor and gasoline drive.

R. C. A. ANNUAL REPORT.—The directors of the Radio Corporation of America, New York, have issued their annual report to the stockholders for the year ending December 31, 1927. Many improvements have been made in the business and a net surplus of $8,478,320 was made as a result of the year's operations.

MARINE SERVICE.—Service to steam and electric marine apparatus is the subject of the booklet "Standing by in Every Port," recently published by the Westinghouse Electric and Manufacturing Company of East Pittsburgh, Pa. This publication consists of a brief discussion of Westinghouse facilities for installation, repair, and engineering assistance for marine apparatus and gives examples of the company's service in the past. A complete list and map of Westinghouse service offices in various ports of the United States is also included.

THE PORT OF NEW YORK AUTHORITY.—The annual report of the Port of New York Authority directs attention to the work done in the last twelve months during which time many improvements in terminal facilities have been made. Space is also given to the discussion of bridges both old and proposed.

NICKEL CAST IRON.—Bulletin No. 205, the fifth of a series on nickel cast iron, has been published by the International Nickel Company of New York. The article entitled "The Practical and Economic Value of Nickel and Chromium in Gray Cast Iron," was written by D. M. Houston. A comparison of costs and savings for various alloys is given.

AUXILIARY TURBINE GENERATOR UNITS.—The Westinghouse Electric and Manufacturing Company, South Philadelphia, Pa., has recently released a leaflet No. 20-338 describing marine auxiliary turbine generators. The leaflet covers units of 5 to 15 kilowatts capacity for direct current operation, using direct connected turbines. This leaflet also describes geared turbine generator units for alterating current service in ratings from 25 up to and including 500 kilowatts.

DOUBLE END GUIDED EXPANSION JOINTS.—Expansion joints using the double end guided principle and applied to pipe lines are dealt with in a bulletin distributed by the Mogul Machine Company, Philadelphia, Pa. Various types of joints are manufactured and their sizes range from ¼-inch to 72 inches in diameter. An interesting feature of this type of joint is the method used to obtain alinement at all temperatures.

Marine Societies

America

American Marine Association. 30 Church St., New York. President—Col. E. A. Simmons.

American Marine Standards Committee. Chairman, Colonel E. A. Simmons. Secretary, A. V. Bouillon, Division of Simplified Practice, Department of Commerce, Washington, D. C.

American Society of Marine Designers. Secretary—B. G. Barnes, 202 Kendrick Ave., Quincy, Mass.

American Society of Marine Engineers. 605 Market St., San Francisco, Calif. President—Henry F. Gelhaus. Secretary—Wm. H. Thille.

American Society of Naval Engineers. Navy Department, Washington, D. C. Secretary Treasurer—Commander H. B. Hird, U. S. N., Bureau of Engineering, Navy Department, Washington, D. C.

American Steamship Owners' Association. 11 Broadway, New York. President—H. B. Walker.

Atlantic Coast Shipbuilders' Association. 1600 Walnut Street, Philadelphia, Pa. Secretary—C. S. King.

Council of American Shipbuilders, Inc... 50 Broadway, New York. President—Homer L. Ferguson. Secretary-Treasurer—Henry C. Hunter.

Jersey Marine Club. 4th and River Streets, Hoboken, N. J. Secretary—Fred L. Broad.

Lake Carriers' Association. President—J. S. Ashley. Secretary—George A. Marr, Rockefeller Building, Cleveland, O.

National Association of Engine and Boat Manufacturers. 29 West 39th Street, New York City. Secretary—Ira Hand.

National Association of Masters, Mates and Pilots. National Secretary—M. D. Tenniswood, 308 Vine St., Camden, N. J.

National Marine Engineers' Beneficial Association. Headquarters 311-315 Machinists Building, Washington, D. C. President—Wm. F. Yates. Secretary—Albert L. Jones.

Neptune Association. 21 Pearl St., New York City. Secretary-Treasurer—Captain John F. Milliken.

New York and New Jersey Dry Dock Association. 111 Broadway, New York. President—Jonathan Moore.

Ocean Association of Marine Engineers. 15 Whitehall St., New York. Secretary—Bert L. Todd.

Port of New York Authority. 75 West Street, New York. Chairman—George S. Silzer. Secretary—Wilson J. Vance.

Society of Naval Architects and Marine Engineers. 29 West 39th Street, New York. Secretary and Treasurer—Daniel H. Cox.

The Maritime Association of the Port of New York. 78 Broad St., New York City. President—John Dowd. Secretary—John F. Manning.

The New York Tow Boat Exchange. 11 Moore St., New York. Manager—Langdon W. Smith.

The Propeller Club of the Port of New York. President—Harry W. Parsons, 111 Broadway, New York. Secretary—W. Z. Gardner, 136 Liberty Street, New York.

United States Naval Institute. Naval Academy, Annapolis, Md. Secretary and Treasurer—Captain H. A. Baldridge, U. S. N.

United States Ship Operators' Association. 149 Broadway, New York. President—Winchester Noyes.

Canada

Grand Council N. A. of M. E. of Canada. Grand Secretary-Treasurer—W. A. MacDonald, 62 Albert St., Halifax, N. S.

Great Britain

Institute of Marine Engineers, Incorporated. 85/88 The Minories, London, E.1.

Institution of Engineers and Shipbuilders in Scotland. 39 Elmbank Crescent, Glasgow.

Institution of Naval Architects. 5 Adelphi Terrace, London, W. C.

North East Coast Institution of Engineers and Shipbuilders. Bolbec Hall, Westgate Road, Newcastle-on-Tyne.

France

Association Technique Maritime et Aéronautique. Secrétariat General—7, rue de Madrid, Paris (8e).

Italy

Collegio Degli Ingegneri Naval e Meccanici in Italia.

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